EBA European Banking Authority

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Discussion Paper

On Defining Liquid Assets in the LCR under the draft CRR

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1. Responding to this Discussion Paper

The EBA invites comments on all proposals put forward in this paper and in particular on the specific questions stated in the boxes below (and at the end of this paper).

Comments are most helpful if they:

- respond to the question stated;
- indicate the specific point to which a comment relates;
- contain a clear rationale;
- provide evidence to support the view expressed;
- describe any alternatives the EBA should consider; and
- provide where possible data for a cost and benefit analysis.

Please send your comments to the EBA by e-mail to EBA-DP-2013-01@eba.europa.eu by 21.03.2013, indicating the reference to 'EBA/DP/2013/01' on the subject field. Please note that comments submitted after the deadline, or sent to another e-mail address will not be processed.

Publication of responses

All contributions received will be published at the EBA's website following the close of the consultation, unless you request otherwise. Please indicate clearly and prominently in your submission any part you do not wish to be publically disclosed. A standard confidentiality statement in an e-mail message will not be treated as a request for non-disclosure. A confidential response may be requested from us in accordance with the EBA's rules on public access to documents. We may consult you if we receive such a request. Any decision we make not to disclose the response is reviewable by the EBA's Board of Appeal and the European Ombudsman.

Data protection

Information on data protection can be found at www.eba.europa.eu under the heading 'Legal Notice'.

Disclaimer

The views expressed in this discussion paper (DP) are preliminary and are aimed at eliciting discussion on the methodology for the carrying out of the analysis of the EBA report under article 481(2) of the draft Capital Requirements Regulation (CRR).

2. Executive Summary

Under Article 481(2) of the draft CRR, the EBA has been mandated to report on appropriate uniform definitions of high and of extremely high liquidity and credit quality of transferable assets and appropriate haircuts for the purpose of the LCR requirements as specified by the draft CRR.

This discussion paper presents the methodology and scope of EBA's forthcoming analysis. Following the outcome of the analysis, the EBA will report to the European Commission on appropriate definitions of high and extremely high liquidity and credit quality of transferable assets for the purpose of the LCR including suggested haircuts. The rationale for publishing the DP at this time is to gather thoughts and useful insights on the methodology that will be employed. The DP is strictly focused on the methodology and does not forward any analytical outputs at this stage.

In this paper, the EBA sets out, for discussion, the suggested methodology and the steps it intends to follow in performing its analysis.

The methodology has been set along a criteria approach where a common set of liquidity metrics will be assessed across all asset classes. An ordinal ranking of asset classes in terms of liquidity will be constructed.

- The EBA's first step will involve the assessment of a range of asset classes against the fundamental definitions of liquid assets included in the draft CRR and test the adequacy of a series of market based metrics in defining the liquidity of different assets. The metrics include for instance trading volume, outstanding amounts, , bid-offer spreads and price stability.
- However the mandate of the EBA implies that the definition of liquidity should not merely be based on assets classes but take into account other characteristics that influence the liquidity and credit quality of assets. In its methodology the EBA will equally test whether explanatory characteristics of individual securities within each asset class can be used to predict their liquidity in quantitative terms. Based on this analysis, the EBA plans to attempt to construct definitions that should be fulfilled by individual assets within a particular eligible asset class, in order to be included in the liquid asset buffer as either transferrable assets of high or extremely high liquidity and credit quality.

Such a detailed quantitative assessment of the liquidity of individual assets being performed, in the end a ranking of the relative liquidity of the different asset classes will be produced, using the framework of market based metrics and explanatory characteristics of individual assets .

- Finally, the analysis will identify the features that are of particular importance to market liquidity. Within individual asset classes that are found to contain assets of high liquidity and credit quality, appropriate haircuts will be proposed, based on the empirical evidence on historical price movements.

It is impossible to prejudge the outcome of the EBA empirical analysis. However, the EBA expects that such criteria and two step approach will deliver an appropriate output for the European Union while not excluding to be more stringent on some assets more specifically compared to global standards.

In calculating the different liquidity metrics, the availability of data is a key issue. Ideally, a comprehensive data set of all trading in an asset is preferable because it enables accurate volume data to be calculated and avoids any selection biases, e.g. where only trades with particular characteristics (such as those traded on a specific platform, or set of traders) are captured. Moreover, observed prices and spreads are preferable to quoted prices and spreads because quotes can be misleading, particularly in stressed market conditions.

The primary source of data for debt securities is planned to be the transaction reporting databases held by national authorities, which were created due to mandatory reporting requirements under the Markets in Financial Instruments Directive (MiFID). For equities, the EBA's intention is to confine the analysis to equities inhabiting the main national index in each jurisdiction, and to gather publicly available daily summary data covering the quantitative metrics required by the draft CRR, which in these more transparent markets should have the same data quality attributes as transactional data. For repo transactions and for other asset classes such as gold, the available data sources are fewer, and the EBA therefore seeks advice on the data sources to be used for these asset classes, in particular.

3. Background and rationale

The recent crisis has again demonstrated the importance of liquidity to the proper functioning of financial markets and the banking sector. Many banks experienced difficulties because they did not manage their liquidity in a prudent manner, being over-reliant on short-dated sources of funding, on funding from other financial institutions, and holding insufficient stocks of liquid assets to withstand a deterioration in funding conditions. The drying up of many funding markets in 2007-08 demonstrated how quickly liquidity can evaporate and that illiquidity can last for an extended period of time, and hence proved the need for institutions to have a prudent approach to managing liquidity risk.

In response to these developments, regulators around the world sought to strengthen institutions' resilience to liquidity shocks by developing two minimum standards for funding liquidity. In December 2010, the Basel Committee on Banking Supervision (BCBS) announced the introduction of a Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR), to be put in place in 2015 and 2018 respectively. The LCR promotes short-term resilience of a bank's liquidity risk profile by ensuring that it has sufficient high-quality liquid assets (HQLA) to survive a significant stress scenario lasting for one month. The NSFR has a time horizon of one year and has been developed to provide a sustainable maturity structure of assets and liabilities. Subsequently, in January 2013 the Basel Committee announced an updated LCR, with subsequent discussions of the 2010 text having led to some substantive revisions to the definition of HQLA and to the implementation timetable of the standard (phased from 2015 to 2019).

In the EU context, on July 20th 2011 the European Commission issued its legislative proposals on a revision of the existing prudential EU regulatory framework (directives 48/2006 and 49/2006, together colloquially referred to as Capital Requirements Directive, or CRD). These proposals have recast the contents of the CRD into a revised CRD and a new Capital Requirements Regulation (CRR), which are colloquially together referred to as the CRR/CRD IV proposals. This revision primarily seeks to apply the Basel III framework in the EU, and therefore the draft versions of these texts also propose the incorporation of the above-mentioned BCBS requirements regarding liquidity into the new EU regulatory framework taking into account European specificities. Negotiations among EU institutions on the CRR/CRD IV proposals are currently ongoing.

The EU intends to monitor the application of international recommendations taking into account European specificities with a reporting requirement of the LCR and NSFR components, and has therefore provided for that in the CRR/CRD IV proposals. Furthermore, the draft CRR text states that by 30 June 2014 the Commission will adopt a delegated act to put the LCR regulation into force no later than 31 December 2015.

A key component of the LCR is the stock of HQLA – a liquidity buffer – which institutions can sell or pledge to withstand a liquidity stress. The 2013 Basel text defines two levels of such liquid assets – the highest-liquidity 'Level 1' assets consisting of central bank reserves, domestic sovereign debt and highly-rated foreign sovereign debt, and the relatively less liquid 'Level 2' assets which include highly-rated corporate and covered bonds, and lower-rated foreign sovereign debt. National authorities are also permitted to allow institutions to hold a part of their Level 2 assets in form of less liquid securities such as lower-rated corporate bonds, high-quality RMBS and major index equities.

The draft CRR tasks EBA with advising on appropriate uniform definitions of liquid assets for such a liquidity buffer, and for this purpose defines two categories of transferableassets: assets of 'extremely high' and of 'high' liquidity and credit quality. The outcome of this work will then be submitted in the form of a report to the Commission, which the Commission can take into account when drafting the LCR delegated act.

More in particular, the CRR proposal stipulates that '*EBA shall after consulting the ESMA and the ECB report to the Commission on appropriate uniform definitions of high and of extremely high liquidity and credit quality of transferable assets for the purposes of Article 404 and appropriate haircuts*.' The CRR proposal requires the EBA to assess a range of asset classes, including but not restricted to those identified as liquid under Art. 404. In particular, the report should also consider (1) other categories assets, in particular RMBS of high liquid and credit quality, (ii) other categories of central bank eligible assets, for example local government bonds, and (iii) other non-central bank eligible but tradable assets, for example equities listed on a recognised exchange and gold. The CRR proposal also specifies a range of criteria and requires that the EBA report '*test[s] the adequacy of [these] criteria*'.

The EBA sets out for discussion in this paper, the steps expected to be followed in performing this analysis. First the EBA is planning to assess a range of asset classes against the fundamental definitions of liquid assets set out in Article 404(3) of the draft CRR. Then a detailed quantitative assessment of the liquidity of individual assets will be performed. The estimates of various liquidity metrics from quantitative data will be used to produce an ordinal ranking of the relative liquidity of different asset classes. Further, the relationship between the characteristics of specific assets and these liquidity metrics will be assessed to identify the characteristics that are of particular importance to market liquidity. This evidence will be used to construct specific definitions of the characteristics of assets that qualify them for consideration as potentially of high, or extremely high liquidity.

The EBA welcomes comments on this Discussion Paper (DP), particular those relating to the technical analysis that is planned, such as the liquidity metrics to be used in the assessment, the methodology to be adopted and the data sources that will be utilised. Specific questions are posed at the end of each section to guide respondents, although responses do not need to be limited to addressing these.

4. Discussion

4.1 Approach to Defining Liquid Assets

Under Article 481(2) of the draft CRR, the EBA is tasked with providing '*uniform definitions of high and of extremely high liquidity and credit quality of transferable assets for the purposes of Article 404 and appropriate haircuts. The report should also consider (i) other categories [of] assets, in particular RMBS of high liquid and credit quality, (ii) other central bank eligible assets, for example local government bonds, and (iii) other non-central bank eligible but tradeble assets, for example equities listed on a recognised exchange and gold*'.

<u>Principles underpinning the EBA analysis</u>

In the broadest terms, a liquid asset is one which can be converted into cash rapidly with little or no loss of value. Although the liquidity of an asset depends on market conditions, the quantity to be monetised and the timeframe considered, there are certain assets that are more likely to generate funds without incurring large discounts in outright sale or repo markets.

The EBA's task is to translate the general definition of liquidity, and the criteria and guidance for classifying liquid assets in the CRR text, into a concrete definition of assets of high and extremely high liquidity and credit quality based on objective criteria, which could serve as a basis for the implementation of the LCR in the EU. The **principles** that are planned to underpin the EBA analysis are listed below:

- Although the definitions will be explicit, they will **be formulated at the level of asset classes, and not individual assets or ISINs**. It will remain the responsibility of individual institutions' to identify appropriate liquid assets to hold to comply with the LCR, working within the broad asset class-level definitions proposed in this report.

- The definition of liquidity will need to **recognise that some asset classes are more liquid than others, and define which assets should be subject to a cap on their usage in the buffer**. The caps on Level 2 assets are an integral feature of the standard and ensure that institutions do not concentrate their liquid asset buffers in higher-yielding but less liquid securities. In compiling a comparative ranking of different asset classes, the EBA will provide a tool to distinguish highly - and extremely highly - liquid assets in EU regulation.
- **Finding evidence that a certain asset class is liquid in a specific EU jurisdiction does not imply that the same asset class would be liquid in all EU jurisdictions**. Therefore, to enable a usable uniform definition of liquid assets to be employed, this analysis will need to probe beyond the broad asset class categorisation to identify the underlying characteristics of assets within each class that make them liquid. For instance, it could be that corporate bonds are defined as liquid only if they are rated above a certain grade and for issue sizes above a given threshold.

- **Only assets issued in EU currencies will be assessed.** While it is accepted that where EU banks face liquidity risk in non-EU currencies it will in many cases be appropriate for them to hold a component of their LCR buffer in assets denominated in those currencies, for the purposes of this analysis, the EBA is considering it more realistic, given also the contemplated timelines for submission of the EBA report, to confine the exercise to the analysis of the liquidity of assets issued in EU currencies.

Some of the asset classes covered by the mandate deriving from Article 481 (2) may not qualify as liquid assets according to the requirements of Article 404. **Where assets do not qualify as liquid assets according to the requirements of Article 404 this will be highlighted**. Also, the nature of certain asset classes may prohibit a full scale analysis due to restrictions on data availability.

Expected output of the EBA analysis

The EBA goal is to comment on the definitions of liquid assets contained in Article 404 of the CRR proposal, thereby identifying the set of possible assets that institutions need to examine when they construct their liquidity buffer. It is planned to do so by providing a definition of these two categories, thus splitting the set of all possible financial assets into three categories: extremely high liquidity and credit quality; high liquidity and credit quality; ineligible.

It is impossible to prejudge the outcome of the EBA empirical analysis. However, we expect our definitions to have the same structure – not necessarily the same contents –as the following fictitious examples: 'Corporate bonds with ratings above A and with issue size above €x mn are assets of high liquidity and credit quality assets. RMBS rated AAA and with a time-to-maturity of at most x years are of high liquidity and credit quality assets.'.

One of the EBA tasks is to 'test the adequacy' of a list of asset- and market-related characteristics such as outstanding volume and credit rating. Again, it is difficult to predict the extent to which a very clear-cut relationship will be obtained. Ideally, a regression (or similar method) would reveal how the asset- and market-related characteristics together predict liquidity (measured by bid-ask spreads or other relevant metrics). In any case, however precise the results we obtain may be, the aim of the EBA analysis is to analyse the appropriateness of the definitions of liquid assets contained in Article 404 of the CRR based on objective criteria to report on uniform definitions of transferable assets of high and of extremely high liquidity and credit quality in an EU context.

The advice on haircuts would presumably be based on observed volatilities.

4.2 Data on Asset Classes

The EBA has performed an assessment of available data sources covering the jurisdictions and assets within the scope of its analysis. There are two simple but crucial characteristics the EBA looked for in comparing the relative merits of different sources of data:

1 A comprehensive data set of all trading in an asset is preferable because it enables accurate volume data to be calculated and avoids any selection biases e.g. where only trades with particular characteristics (such as those traded on a specific platform, or set of traders) are captured;

2 Observed prices and spreads are preferable to quoted prices and spreads because quotes can be misleading, particularly in stressed market conditions.

Taken together, these two characteristics are best met via transactional data.

MiFID Transaction Reports

Transactional data can be obtained from many sources, including exchanges and trading platforms, market data providers and institutions, but as fixed income products are generally traded over the counter (OTC), data from many different sources are often required to give comprehensive coverage. This appears to be especially the case for non-government bond markets. Therefore for the purposes of this analysis the primary source of data for debt securities is planned to be the transaction reporting databases held by national authorities, which were created due to mandatory reporting requirements under the Markets in Financial Instruments Directive (MiFID)[1]. Due to the comprehensive nature of the MiFID requirements, this data source encompasses a comprehensive set of transactions involving all securities admitted to trading on domestic regulated markets, and going back at least to the start of 2008. While this data is collected in individual jurisdictions, MiFID rules specify standardised reporting fields which should enable the data to be compared across jurisdictions. Annex 3 sets out the most important data fields of the MiFID reporting to be used in the analysis.

Transactional data collected under the MiFID reporting rules is primarily intended to be used to detect market abuse, therefore we expect that significant amounts of data cleaning will be required to ensure the data is in the form required for this analysis. For example transactions are typically reported by all parties to the trade, so duplicates will need to be removed to give accurate volume statistics. Important fields such as traded price and trade size may occasionally be misreported and hence outliers will need to be identified and removed. In addition we will need to estimate effective bid-offer spreads from transaction prices using methods such as that outlined in Roll (1984)[2].

MiFID reporting requirements were only introduced in 2007, with the precise implementation date varying slightly among jurisdictions. Therefore although in some jurisdictions similar reporting requirements existed previously, the EBA intends to focus its analysis on the period from the start of 2008 to the end of June 2012. While a longer run of data should ideally be used, this sample *does*

[1] MiFID introduced a standardised set of requirements across the EU for firms engaged in the provision of investment services to report trading activity for any instrument admitted to trading on a regulated market.
[2] Full bibliographical references can be found in Annex 6 of this paper.

cover a significant period of liquidity stress and hence it is very relevant to the issue under investigation in this work.

While credit rating thresholds are an important feature of eligibility criteria for liquid asset buffers, the EBA intends to collect data on assets with a wide range of different credit ratings to enable a full analysis of the importance of rating as a determinant of liquidity. No restrictions on trade size, issuance size and maturity have been employed in gathering the MiFID dataset.

Equity Data

In addition to encompassing a range of fixed income securities, the mandate includes equities, therefore their liquidity in a European context must be examined in the EBA report. The EBA intention is not to work with transaction level data for equity markets, as the quantity of data obtained via this method would create significant data handling challenges. Therefore it is planned to confine the analysis to equities inhabiting the main national index in each jurisdiction, and to gather publicly available daily summary data covering the quantitative metrics required by the CRR, which in these more transparent markets should have the same data quality attributes as transactional data, without posing the same operational challenges.

Data on gold

Comprehensive data on gold trading is difficult to obtain from public sources, and is not provided in MiFID transaction reports. However, the EBA have obtained detailed survey data from the World Gold Council that the EBA intends to utilise in the report.

Additional Data Sources

The EBA intends to supplement its work on transactional data via the use of less comprehensive data gathered from a range of data providers as a means of performing robustness checks on the primary data source. Ideally data on securities trading should be supplemented with data on turnover in repo markets, however the EBA has concluded that a source that would enable examination of the volume of trading at an ISIN level across the asset classes covered in the EBA report is not available.

The EBA does not, at present, plan to examine data on securities traded in currencies from outside Europe, although it acknowledges that in some cases these will be eligible assets.

Questions

Q1. Given the difficulties with obtaining transactional data outlined here, do you think a data sample cover 2008-2012 is sufficient for this analysis? Would you see merit in extending the sample in those countries where more data is available?

Q2. Do you have additional data sources to suggest? Specifically, can you suggest a source of repo data and gold that would fit our needs?

4.3 Liquidity Metrics and Explanatory Characteristics

The objectives of the EBA analysis are to: (i) establish a ranking of asset classes based on their aggregate liquidity properties; and (ii) identify explanatory characteristics of individual securities that explain observed liquidity differences within asset classes. To achieve this, the EBA plans to use a two step approach:

1) Assess a common set of *liquidity metrics* across all asset classes. These metrics will be computed first at the ISIN level, but the primary analysis will focus on aggregated results by asset class. An ordinal ranking of asset classes in terms of liquidity will be constructed.
2) Test whether *explanatory characteristics* of individual securities within each asset class can be used to predict their liquidity in quantitative terms. Based on this analysis, the EBA plans to attempt to construct definitions that should be fulfilled by individual assets within a particular eligible asset class, in order to be included in the liquid asset buffer as either transferrable assets of high or extremely high liquidity and credit quality.

Article 481(2) of the draft CRR prescribes a set of quantitative metrics that, at a minimum, need to be analysed in the process of producing the EBA report. Analysing this set of metrics will form a central pillar of the EBA work, however it is proposed to take a broader approach and assess an expanded list of liquidity metrics and explanatory characteristics, where data is available.

The method to determine eligibility must produce comparable tests for all assets, regardless of the jurisdiction or any other characteristic that would not affect liquidity. Consequently, the importance of comparability is emphasized in at least two ways:

- The explanatory characteristics and liquidity metrics used should be rich enough so that we can compare the liquidity properties of fundamentally different securities.
- It must be possible to calculate the liquidity metrics for all asset classes. This will place significant constraints on the range of metrics that can be used, for example a metric that is only applicable in an order book market, or to a specific asset class cannot be used.

Liquidity Metrics

The CRR draft text states that the '*EBA shall in particular test the adequacy of the following criteria and the appropriate levels for the definition of transferrable assets of high and extremely high liquidity and credit quality:*

a. minimum trade volume of the assets;
b. minimum outstanding volume of the assets;
c. transparent pricing and post-trade information;
d. credit quality steps referred to in Part Three, Title II, Chapter 2 (credit ratings);
e. proven record of price stability;
f. average volume traded and average trade size (trade volume / number of trades);
g. maximum bid/ask spread;
h. remaining time to maturity;

i. *minimum turnover ratio (trade volume / outstanding volume)*'

In the EBA's view this list of criteria can be divided into two distinct categories; (1) Liquidity and activity measures, and (2) asset characteristics.

1) **Liquidity and activity measures.** Criteria (a), (e), (f), (g) and (i) are criteria that relate directly to the market liquidity and activity of assets. Criterion f) prescribes the aggregate minimum trading volume and average trade size in an asset to be important metrics, while (a) sets a lower bound on aggregate trading volume. Criterion (e) refers to the price volatility (price stability) of an asset, which may be seen as a slightly vague criterion that should be made more explicit. One possibility is that it should be defined in excess volatility terms, where excess volatility refers to non-fundamental volatility (price movements due to other sources than new information or systematic risk). An asset's excess volatility can be a measure of liquidity as assets with lower excess volatility typically would be more liquid (e.g. lower price impacts, less disagreement about value) than assets with high excess volatility for which prices move more due to non-information based trades. Criterion (g) (bid ask spread) is a widely applied measure of the cost of demanding liquidity across most assets and is a key metric, and (i) is an activity measure that measures how frequently the outstanding volume of an asset is traded over a fixed interval (e.g. month). More liquid assets typically have a higher turnover ratio. Assessing the behaviour of these quantitative based liquidity metrics will be central to the assessment of the relative liquidity of different asset classes (although as discussed below, in practice there are a wide range of possible spread and volatility measures to choose from). Also, the finer distinction between activity and liquidity measures may be particularly important during periods of stress as several studies (see e.g. Aitkin et. al (2003) and Fleming (2003)) find that activity measures may falsely signal high liquidity during periods of stress. In periods of stress the cost of obtaining liquidity may be high (wide bid ask spreads, large price impacts, etc.), but investors are willing to accept these high transaction costs to liquidate or rebalance positions.

2) **Asset characteristics.** Criteria (b), (c), (d) and (h) are metrics that reflect more fundamental attributes of assets that are generally found to be important determinants of liquidity. Outstanding volume b) of an asset typically refers to the size of the issue, where larger issues are generally considered more liquid (see e.g. Houweling et al., (2005)). The transparency of the market process, criterion (c) is also important for the incentives and costs of providing liquidity. Credit quality, criterion (d) is closely linked to liquidity as low quality assets typically have greater information asymmetries and larger bid ask spreads. Time to maturity, criterion (h) is also an important characteristic as issues with shorter time to maturity are to a greater extent 'locked' into investors' portfolios which reduces market activity and liquidity. This is illustrated by the significant liquidity difference between on- and off-the run bonds, where off-the-run bonds are typically less liquid relative to their on-the-run counterparts (see Goyenko et al, (2011)).

We intend to expand the range of quantitative based liquidity metrics to supplement those liquidity and activity measures discussed in point 1) above for the purpose of obtaining a more precise measurement of liquidity across asset classes. The motivation for the additional measures is based on insights gained from the literature reviews in Annex 1 and 2. One take away from the review, is that liquidity needs to be assessed across different dimensions simultaneously. The choice of measures is based on the following main considerations. First, the measures should be relatively simple to implement and should be suitable (and have been applied) for a range of different asset classes. Second, the measures should have a track record of being applied in the literature either in published papers, in ongoing work (working papers) by prominent researchers, or being used in practice. A final important point relates to the frequency of the data. While some measures are tailored for intraday data, such data is not readily available for all asset classes. Hence, the set of measures should cover measures that are tailored for intraday data as well as measures (of similar type) that are tailored for data observed at the daily frequency or lower. As discussed in the literature review, there are several recent studies (e.g. Fong et al, (2011)) that evaluate the performance of low frequency liquidity measures against their high-frequency counterparts. Since we will examine a number of asset classes with observations sampled at different frequencies, it is important to have a broad set of metrics to facilitate measurement both at the intraday and daily frequencies.

When defining market liquidity earlier, we proposed that the classifications in Harris (1991) would be a useful guide for proposing a set of measures that covers the most important aspects of liquidity. The additional metrics that the EBA has identified so far are relating to the width and depth dimensions of liquidity.

Width metrics

Regarding point (g) above, as discussed in the literature review, the size of the spread ('width') can be measured in several ways and for different data frequencies. For intraday transactions data, but without actual bid/ask quote observations, the Roll (1984) effective spread estimator is widely applied. For assets where only daily data is available, a simple and powerful measure is the Fong, Holden and Trzcinka (2011) spread measure. This measure only requires returns and the fraction of days that the asset is traded during a period (e.g. month). Also, some data sources provide end of day bid and ask quotes for individual securities (e.g. Thomson Reuters Datastream for equities). In these cases, one can obtain a relatively good estimate of the spread when averaging across several securities within an asset class. In these cases, the quoted- or proportional spread can be easily calculated.

Depth metrics

Direct measurement of 'depth' requires intraday order level data. For practical purposes that will not be feasible for the current analysis as the number of markets and asset classes that will be tested is very large. As an alternative, there are a several depth proxies that are commonly applied in the literature to measure price impact of trades. The most widely applied measure is the Amihud (2002) illiquidity ratio (ILR), and a modified version of the ILR measure proposed by Dick-Nielsen, Gyntelberg and Sangill (2012). These measures are typically applied to daily data, but can also be applied to intraday transactions data for fixed windows. Another relatively simple measure that may be applied is the price reversal measure of Bao et al (2011), which is suitable for low frequency data and only requires daily returns. This measure has also been successfully been applied to bonds.

The choice and applicability of different liquidity measures depends on the final data sources and the observation frequency. We have also identified an additional liquidity metric that specifically relates to the purpose of the LCR, although it has not featured prominently in the literature to date, *the covariance of price movements with financial market stress* would capture the 'flight to quality' characteristics demonstrated by some asset classes, which mean that their value is positively correlated with the probability of their holder needing to liquidate them.

Explanatory Characteristics

We have identified a number of explanatory characteristics which we expect will be useful in predicting the relative liquidity of individual assets. We will test the explanatory power of these characteristics using the liquidity metrics. If a relation between a specific characteristic and the liquidity of the asset class is proven, for example if it is possible to show how the issue size of a corporate bond affects its price volatility, trading volume and bid-offer spread, it will be possible to use that explanatory characteristic to supplement the threshold definitions for liquid assets set out in draft CRR Article 404(3), and to more narrowly define the eligible subsets of asset classes in Article 404.

The EBA has identified a set of general explanatory characteristics that it expects to have relevance across all asset classes, which can be further sub-divided into those that refer to market structure and those referring to the properties of an asset. The EBA has also started to develop its thinking on a range of specific characteristics that would only apply for a sub-set of asset classes.

General explanatory characteristics that refer to the market structure would include:

- Presence of a large number of market makers
- Trade via additional platforms and markets
- Wide range of potential buyers
- Transparency

General explanatory characteristics specific to an asset would include: :

- Collateral eligibility
- Credit rating
- Issue size
- Remaining time to maturity

Annex 4 provides more details on these characteristics. In order to test these general explanatory characteristics against the liquidity metrics, additional characteristics may be explored for individual asset classes. Examples of possible characteristics are given in Annex 4.

Questions:

Q3. Do you agree with the list of liquidity metrics under consideration to be used in the EBA assessment, as mentioned in this section and Annex 5? Can you suggest further metrics the EBA should make use of, where information would be available?

Q4. Do you agree with the list of explanatory characteristics whose linkage to liquidity is proposed to be tested in the EBA assessment? Can you suggest further characteristics the EBA should assess?

4.4 Methodology

Once the EBA has finalised the list of liquidity metrics and explanatory characteristics to be used in the assessment, and gathered the necessary data on these, it plans to proceed with the analysis of relative liquidity of the asset classes that fall within the scope of this exercise. This section of the DP outlines the aims of the analysis and the main steps envisaged taking in order to achieve each aim.

The methodology that the EBA plans to use takes a broad approach to liquidity measurement, aiming to fulfil the criteria identified in the CRR as well as being consistent with the methods used in the existing literature. As discussed in Section 4.1, it is planned to focus the analysis on identifying the more liquid asset classes, rather than on examining the liquidity of individual assets ISIN by ISIN, or identifying which measures best capture market liquidity. In that sense the analysis will be somewhat similar to, although with a broader scope than, studies such as Dick-Nielsen, Gyntelberg and Sangill (2012), which compare the liquidity of different asset classes (a range of studies examining the liquidity of specific asset classes are discussed in some detail in Annex 2).

The EBA aims to take advantage of the MiFID dataset on individual securities transactions described in Section 4.2 to compute the liquidity metrics described in Section 4.3. There are three main aims in the EBA's analytical work:

1. Producing an ordinal ranking of the relative liquidity of different asset classes

The analysis should consider whether this ranking holds constant across countries and over time. In addition, the relative ranking should help affirm which asset classes can be considered 'extremely highly liquid' and which 'highly liquid'.

2. Within individual asset classes identifying the key explanatory characteristics that determine the relative liquidity of individual assets.

Within each asset class, some assets will be more liquid than others. Identifying the characteristics that influence asset liquidity will enable the EBA report to identify the minimum qualitative standards that can form part of the liquid asset definition in the CRR. In addition it can provide the basis of guidance that institutions and supervisors will use to identify the desired liquid asset holdings beyond what is specified in the minimum CRR requirement.

3. Within individual asset classes that are found to contain assets of high liquidity and credit quality analysing empirical evidence on historical price movements in order to propose appropriate haircuts.

The following is a discussion of the main analytical steps anticipated to be followed to achieve each of the above-mentioned aims.

Liquidity metrics and ranking of asset classes

Ranking the relative liquidity of the asset classes the EBA is tasked with examining, would enable policy makers to ground their decision making on the classification of highly liquid and liquid assets in empirical analysis. While precisely defining where the cut-off should be made between eligible and ineligible asset classes may be somewhat subjective, a relative ranking would in principle ensure that wherever that line is drawn, assets falling outside the classification will not be more liquid than those falling within.

To produce the ordinal ranking it is proposed to calculate the liquidity metrics for each qualifying asset class and analyse the behaviour of individual metrics through time and across assets. This task will involve calculating the metrics identified in Section 4.3 for the asset classes identified in Section 4.1. First the EBA plans to analyse the behaviour of metrics over time at an asset class level, both for the EU as a whole and at a level of individual countries.

The next step would be to perform a similar analysis at the level of individual assets. Here plotting individual asset time series would result in too many outputs to compare against one another, so it is planned to represent these findings using probability distributions, potentially showing these over different time periods. The case study in Section 4.5 provides specific examples of how this might be achieved

Breaking asset classes into their constituent components is expected to show whether the ordinal rankings observed at aggregate level hold more generally at the level of individual assets.

The EBA would then focus on the co-dependence of selected liquidity metrics with metrics of liquidity stress for each asset class to capture its liquidity properties under stress.

The final step of the EBA work would be to analyse combinations of liquidity metrics with a view to producing an ordinal ranking of the relative liquidity of asset classes. Data from the liquidity metrics can be combined with the assessment against the qualifying criteria to produce the ranking. This step will involve looking across the range of metrics, and combining the results to produce an overall liquidity assessment, which will then enable the EBA to rank different asset classes according to their liquidity.

There are several difficulties that will probably be encountered in this process. The EBA will be assessing a number of different liquidity metrics, and it is extremely unlikely that each metric will indicate the same ordinal ranking, for example it is likely that highly rated corporate bonds will have lower price volatility than equities, but also lower trading volumes and wider bid-offer spreads. Similarly it seems unlikely that the same ordinal rankings will hold across all countries or across all time periods. In such cases EBA will try to establish the relative importance of the different factors. However, EBA is not specifying *ex ante* a precise methodology for combining metrics together to provide the ranking.

Following these steps and referring to the tentative ordinal ranking a further analysis will be run, looking for sub-groups of assets with distinct liquidity characteristics within overall asset classes.

Explanatory characteristics and ranking within asset classes

Having produced a tentative ordinal ranking it is proposed to refine the resulting understanding of the determinants of liquidity within asset classes by assessing the extent to which variation in key liquidity metrics can be explained with reference to qualitative factors. The explanatory characteristics described in Section 4.1 will be used for this assessment. The EBA would expect to use probability distributions and possibly regression analysis to perform this tasks, and would likely focus largely on the tails of the probability distributions.

This analysis will help further refine the ordinal rankings that will have been produced, enabling to differentiate the liquidity of different groups of assets according to their explanatory characteristics. This will perform two functions:

- Help enhance the existing definitions of liquid assets via the use of specific explanatory characteristics.
- Providing guidance for institutions on the factors they need to take into account when determining which assets are appropriate for their buffer within the set of eligible asset classes.

Question

Q5. Do you agree with the methodology proposed? Do you have alternative approaches that might be used?

4.5 Illustrative Case Study

This section presents a short case study illustrating how the EBA intends to go about the analysis, to illustrate the approach set out in the preceding sections of the paper. This case is simplistic due to present data limitations. It uses a different dataset to MiFID and remains purely illustrative of the methodology while not of the analytical outputs..

Step 1: Collect the Data

The database chosen for this task was UBS Delta, which provides ready-made data on bid-ask spreads and prices of different debt securities. In this case study, only bid-ask data is used, as the price data were not made available for individual securities.

The database has the following characteristics:

- Data is based on quoted spreads, unlike the MiFID data which is based on physical transactions. The EBA has a preference for using transaction-based data such as MiFID rather than quoted data, if available.
- Data available covers the bid-ask spread and credit rating. Prices data is not used in this case study and no volume data is available from UBS Delta.
- Data is available on a daily basis dating back to 2004, both at the individual ISIN level, as well as an index for a particular asset class (though some index data start at a later date).
- Data covers a range of securities: sovereign bonds, covered bonds, corporate bonds and ABS. Data cover all EU countries, but importantly only certain securities are available for certain countries.

Step 2: cleanse the data

The data was of sufficient quality to be used in its original format. This will not be the case with the MiFID transactions data which will require substantial cleansing. However, a number of important data coverage limitations were uncovered when studying the dataset, which resulted in a decision to reduce it to produce a comparative analysis. These limitations are that:

- Sovereign bonds are all highly rated (AAA-AA), and most covered bonds and RMBS are highly-rated, whereas only a small proportion of corporate bonds are.
- Pretty much all the ABS data are for the UK.

Therefore the EBA has restricted the dataset to only cover AAA-AA rated securities, achieving a more fair and comparable coverage across countries and asset classes.

Step 3: calculate the metrics

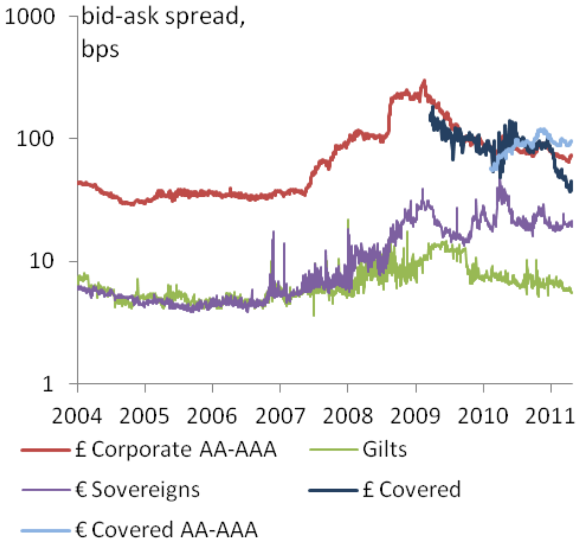
The EBA has calculated the bid-ask spread liquidity metric based on UBS Delta, for the asset classes present in the dataset. The metric was calculated at two levels:

- At an asset class level. This is based on index data and allows analysis of the behaviour of the liquidity metric for the asset class as a whole over time. Chart 1 shows the time series for the data for a range of currency denominations (Euro and sterling).

- At an individual ISIN level, but still distinguishing by asset class. Here plotting individual asset time series would result in too many outputs to compare against one another, so these findings have been represented using probability distributions, showing these over different time periods. Charts 2-5_show the relevant distributions. The results are presented both for a sample of EU countries (Charts 2-4), and for one individual jurisdiction – the UK (Chart 5).

In its final report the EBA intends to use a broader range of metrics, and focus more on transactions rather than quotes data, as outlined in Section 4.2.

Chart 1: Time series of bid-ask spreads by currency and asset class (logarithmic scale)



Bid-ask spread is adjusted for duration.

Chart 2: Probability distribution of bid-ask spreads by asset class: selected EU countries, AAA-AA rated securities; 2004-07

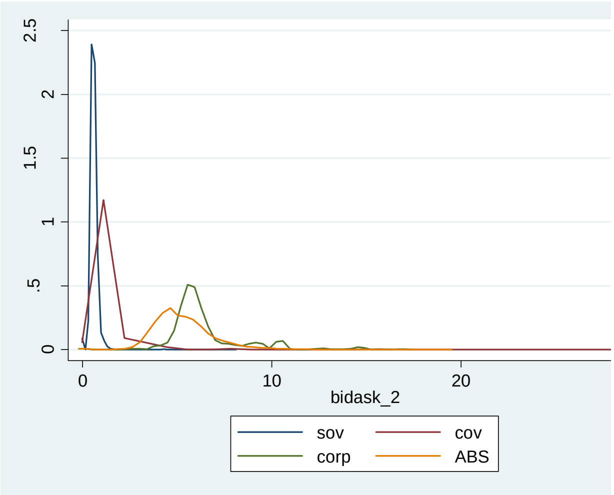


Chart 3: Probability distribution of bid-ask spreads by asset class: selected EU countries, AAA-AA rated securities; 2007-09

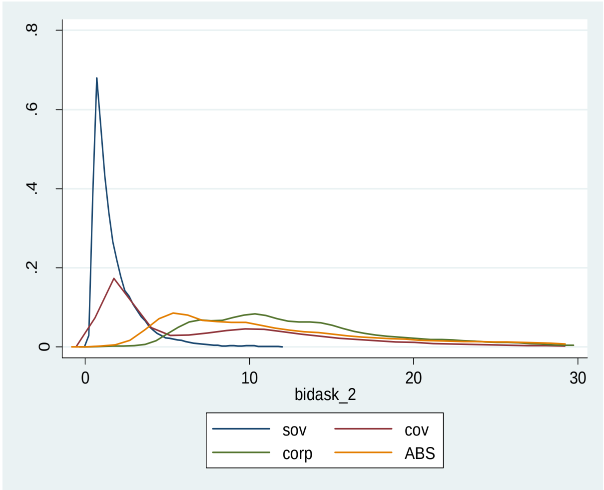


Chart 4: Probability distribution of bid-ask spreads by asset class: selected EU countries, AAA-AA rated securities; 2010-12

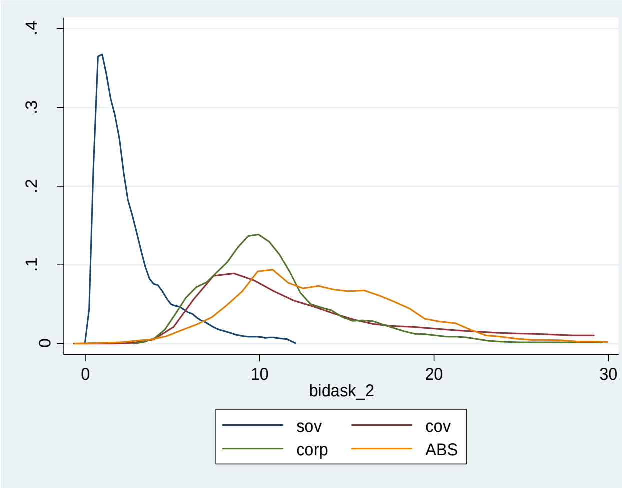
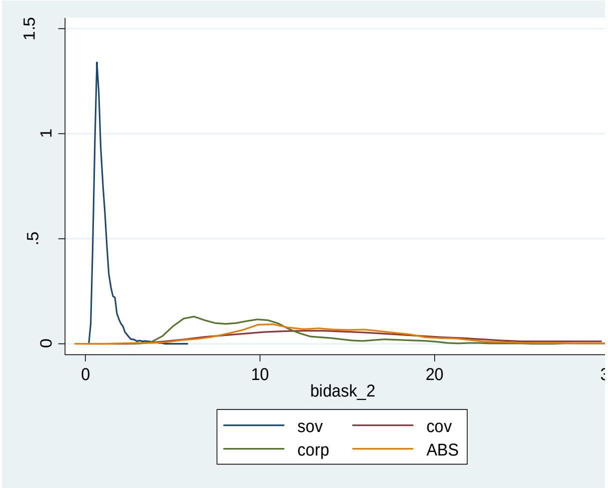


Chart 5: Probability distribution of bid-ask spreads by asset class: UK, AAA-AA rated securities; 2004-12



Step 4: analyse the data and produce an ordinal ranking

In this step, it is planned to analyse the performance of different asset classes over time according to the set of liquidity metrics.

As an example, looking at the bid-ask data presented above would lead to several broad conclusions. Chart 1 suggests that sovereign bonds tend to be more liquid than corporate and covered bonds on average, based on the bid-ask metric. From Charts 2-5 it can be seen that although this is the case, there are some covered and corporate bonds that may be of similar liquidity to certain government bonds, in particular during the period of the recent sovereign crisis. However, whilst this is true more generally for our broad sample of the EU countries, this does not seem to be the case for the UK data in Chart 5, where sovereigns consistently outperform other, even highly rated, private sector securities in terms of the bid-ask spread. The overall ranking based on this one metric would distinguish sovereign bonds as generally more liquid than corporate, covered bonds and ABS, but it is difficult to judge the relative liquidity of private sector securities against each other, not least because of substantial variation in the data.

Step 5: determine the explanatory variables that classify a particular asset as liquid

Charts 2-5 show a wide spread of liquidity performance among individual bonds in a particular asset class across the EBA sample of different EU countries, and for private sector bonds even in the case of an individual country, the UK. Therefore it would be helpful to distinguish the more liquid bonds inside a particular asset class from less liquid ones.

The MiFID analysis will use a variety of metadata to identify such explanatory variables. The UBS Delta sample is lacking such detailed metadata, but one such variable might be the credit rating. Table 1 below summarises the mean bid-ask spread and bid-ask volatility of covered bonds by their credit rating. As expected, higher-rated covered bonds appear to have lower and less volatile bid-ask spreads.

Table 1: mean bid-ask spread and bid-ask standard deviation for covered bonds for selected EU countries

Rating	AAA	AA	A	BBB
Bid-ask spread	10.6	16.5	20.4	42.6
Standard deviation of bid-ask spread	8.9	15.6	22.7	44.5

After performing such analysis the EBA will be able to tell which asset classes are relatively more liquid than others, and which explanatory variables may be used to determine whether a particular asset within a qualifying asset class is liquid or not.

Annex 1: Literature on Market Liquidity

This section provides a definition of liquidity and summarizes the literature on liquidity measures and methods to guide and motivate the liquidity measures intended to be adopted in the EBA methodology. Due to the breadth of this literature, the overview needs to be limited and focuses mainly on empirical methods and metrics that are of direct relevance to the project. To supplement the overview references to more extensive literature surveys on the topic are provided in Annex 6.

The first section below provides a definition of market liquidity, the one after that surveys the most relevant literature on liquidity and liquidity measurement. The last section provides a summary of empirical results regarding actual liquidity estimates, and measures applied, for different asset classes.

Defining liquidity

When attempting to measure and analyse liquidity, one must confront a basic question: how should liquidity be defined? At the general level, it is a simple concept. However, the exact meaning of liquidity is far from apparent, and how one defines it has implications for how one goes about measuring it. Liquidity also means different things to different traders, depending on their characteristics and typical trading needs. An early general definition of liquidity can be found in Keynes (1930), who considers an asset as more liquid *'if it is more certainly realisable at short notice without loss'*. As defined by O'Hara (1995), '*a liquid market is one in which buyers and sellers can trade into and out of positions quickly without having large price effects'.* Implicit in these definitions is the notion that a liquid market has the ability to absorb large liquidity demands without generating excess volatility. The absorption capacity of markets is of particular importance in the case of LCR, as a funding shock to institutions would potentially trigger a joint liquidation of LCR assets by the banking sector. Thus, the EBA will focus on the absorption capacity of markets and measure liquidity accordingly.

To provide this absorption capacity markets rely on some form of liquidity suppliers that are willing to take the opposite side in transactions initiated by traders that demand liquidity. Who these liquidity suppliers are differs across market structures. For example, quote driven markets (dealer markets) rely on intermediaries such as designated market makers, specialists or dealers that continuously post bid and ask quotes at which they are committed to buy and sell a specified quantity of the asset. In pure limit order markets, on the other hand, there are no formal intermediaries, and liquidity is provided through limit orders submitted by the traders themselves (the limit order book). Hybrid markets (e.g. New York Stock Exchange) rely on liquidity provision by both designated market makers (former specialists) and limit order traders, while non-continuous markets (e.g. call markets) concentrate all trading interest at discrete points in time. The EBA will be attentive to the details of the market structure.

Traders that demand liquidity are typically impatient and willing to pay a cost to liquidate or build a position quickly, while patient traders are willing to supply liquidity to the more impatient traders. Most liquidity measures attempt to measure the cost associated with demanding liquidity, or analogously the compensation required to supply liquidity. As such, variables that measure for example the frequency of trading activity may not in isolation be appropriate liquidity measures as e.g. a high frequency of trading activity does not necessarily map into low implicit costs associated with executing these trades. To obtain a direct measure of liquidity one would need trading activity to be translated into a measure of costs or examined in conjunction with other liquidity measures. This point has been made by e.g. Aitkin and Commerton-Forde (2003), and more recently by Vayanos and Wang (2012).

The above description does not provide much guidance with respect to how exactly liquidity should be measured. For this purpose, Harris (1990) attempts to provide a more operational definition of market liquidity and proposes that liquidity can be defined through four interrelated dimensions; *width, depth, immediacy and resiliency*;

- *Width* reflects the cost of demanding liquidity (as opposed to supplying it) and is typically captured by the size of the bid ask spread. While the spread measures the cost incurred by consuming liquidity immediately ('crossing the spread'), it does not capture the quantity that can be transacted at the best quotes.
- *Depth* refers to the quantity of liquidity supplied, and is typically measured by the volume offered at the bid and ask quotes.
- *Immediacy* refers to how quickly a large trading need can be accomplished. In most continuous markets small orders are typically executed immediately. However, large orders (e.g. by institutional traders) may take time to execute without incurring large costs. In an illiquid market, a large trader may incur significant delay costs if prices move during the time it takes to build the position. This cost is commonly referred to as implementation shortfall (see e.g. Perold, 1988). Immediacy may also reflect search costs, which can be significant in e.g. OTC markets (see e.g. Duffie et al, 2007).
- *Resiliency* refers to the time it takes for the price to return to the pre-trade equilibrium level after a large (uninformed) order consumes liquidity. While resiliency was initially defined with respect to prices, resiliency can also be defined as the speed at which liquidity (quotes and depth) replenishes to equilibrium levels after a large liquidity shock.

An important insight from the above discussion is that several measures are typically needed to get an accurate picture of an asset's market liquidity. For example, a tight bid ask spread is not enough to define an asset as extremely liquid unless a large quantity can be transacted at the best quotes relatively quickly. For e.g. large traders that split up their orders into smaller chunks to minimize transaction costs, resiliency and immediacy are also very important. In other words, while the dimensions proposed by Harris (1990) are closely related, individual liquidity metrics are typically only able to capture some facets of liquidity. Hence a combination of liquidity measures that capture different aspects is required to get a complete picture. The EBA plans to use a variety of measures in its analysis.

Measures of market liquidity

When structuring the vast literature on market liquidity, the liquidity dimensions proposed by Harris (1990) are useful as a general framework to think about different liquidity measures. However, since many measures and methods aim at capturing several aspects of liquidity simultaneously, the EBA will mainly use his definitions to interpret the measures proposed in the literature.

There are several recent papers that provide a comprehensive literature overview. For example a recent paper by Vayanos and Wang (2012) gives a detailed overview of both the theoretical- and empirical literature on market liquidity. In this overview, however, the focus is mainly on the empirical literature with particular focus on liquidity measures that are applicable to this project. It is also important that the measures are relatively simple and transparent as they will be applied to a broad range of assets and markets. However, accuracy and (proven) quality of a measure should not be sacrificed for simplicity.

Another important aspect is the distinction between liquidity measures that rely on high frequency transaction and/or order level data versus measures that rely on low frequency data (e.g. daily data). While in the Final Report the EBA intends to use detailed transaction data (MiFID data), it will also cover measures that are tailored to be estimated using daily data since such measures will be useful for evaluating the liquidity of asset classes for which the EBA does not intend to gather transaction level data. Finally, it should be noted that the major part of research on liquidity measurement historically has focused on equity markets due to the superior data availability. However, more recent studies on the liquidity of other asset classes (e.g. corporate bonds) typically apply the same measures initially developed for equity markets. In the cases where there are concerns regarding the applicability of a measure to a specific asset class or market structure, those will be explicitly noted.

Spread measures

The most widely applied proxy for liquidity is the bid ask spread. As noted above, spread measures relate to Harris' (1990) width dimension of liquidity. A large part of the theoretical market microstructure literature focuses on understanding why a positive bid ask spread appears in equilibrium and which factors give rise to cross sectional differences in spreads. Overall, these studies have established that the spread consists of three main cost components; inventory costs, order processing costs and adverse selection costs (see e.g. O'Hara, 1995). In dealer markets, these costs are incurred by the market makers who typically set a zero-profit (competitive) spread that exactly covers these costs. An important part of both the theoretical and empirical literature focuses on the adverse selection cost component of the spread which is defined by the market makers expected loss to privately informed traders (see Glosten and Milgrom, 1985).

In the empirical literature several spread measures are commonly applied that capture different aspects of transaction costs. The most basic spread measure is the quoted spread (QS), which is simply measured as the difference between the highest bid quote (B_k) and the lowest ask quote (A_k) associated with transaction (or quote update) k, $QS_k = A_k - B_k$. While this is a direct measure of the roundtrip cost associated with trading a *small* quantity of an asset, it is commonly expressed relative to the bid/ask midpoint price such that the proportional spread (PS) can be expressed as $PS_k = QS_k / M_k$, where $M_k = (A_k + B_k)/2$.

Since trades in dealer- or OTC markets can occur inside the prevailing best quotes, the effective spread might provide a more accurate measure of the spread. The effective spread (ES) for transaction k is typically measured as, $ES_k = q_k(P_k - M_k)/M_k$ where q_k is a signing variable that takes the value 1 if the trade is initiated by a buyer and -1 if the trade is initiated by a seller. In many transaction datasets, however, there is no indicator variable (q_k) explicitly stating whether a trade was initiated by a seller or a buyer. In those cases, the standard method used in the literature is the Lee and Ready (1991) algorithm. This algorithm simply checks whether transaction k occurs above (buyer initiated) or below (seller initiated) the bid/ask midpoint prevailing just before the trade occurs. In the cases where the trade happens exactly at the prevailing midpoint, the standard procedure is to check the transaction price against the midpoint for longer lags. Ellis et al. (2000) examine the accuracy of the Lee and Ready (1991) algorithm and show that it is able to sign about 76% of transactions correctly.

An issue not discussed above is that intraday measures of the spread are also commonly volume weighted or time weighted. By weighting the individual spread observations by the total volume traded, one would obtain a spread measure that reflects more accurately the actual costs realized by traders. The time weighted spread is typically calculated by weighting each spread observation by its intraday duration, which gives a more representative spread measure if there are long periods with the same spread. Calculating a time weighted spread, however, typically requires order level data.

In cases when one do not directly observe the bid and ask quotes the literature suggests several implicit spread estimators. The best known estimator is proposed by Roll (1984) that exploits the fact that trades typically occur at, or within, the bid and ask quotes. As such it is closely related to the effective spread measure discussed earlier. The main idea is that transaction prices tend to 'bounce' between the (unobserved) bid quote and ask quote as buyer and seller initiated trades execute against these quotes. This generates a negative autocorrelation between consecutive transaction prices (and returns), which can be used to map out the size of the spread. The Roll (1984) implicit spread estimator for a time window t is simply estimated as, $Roll_t = \sqrt{-cov(r_{k-1}, r_k)}$, where $r_k = p_k - p_{k-1}$.

There is also a growing part of the literature that examines low frequency estimators of the spread that only require daily data. These studies are very useful as they offer methods that make it possible to construct long liquidity time series for large samples of individual assets. There are several recent measures that are shown to be very good when evaluated against actual high frequency spread measures. One early estimator is the LOT measure proposed by Lesmond, Ogden, and Trzcinka (1999) that exploits the information inherent in zero-return-days to estimate the effective transaction costs for any asset. The basic idea is that assets with large spreads require larger information value for new information to be traded into the price. Hence, if the value of new information is less than the costs of trading, prices will not move. They show that their measure is highly correlated with spread measures calculated using actual quote observations. While the LOT measure requires relatively little data, it needs to be estimated by maximum likelihood, and more importantly requires the return on a market index. While the requirement of having the return on a market index is unproblematic for equities, for other asset classes and markets the availability of high quality benchmarks are not readily available.

To solve this issue, Fong, Holden and Trzcinka (2011) propose a simplified and less data intensive version of the LOT measure, which they coin FHT. They evaluate the power of this measure against other low frequency and high frequency proxies estimated for more than 18 000 stocks listed on 43 different exchanges around the world, covering a period of more than ten years. The measure is shown to strongly dominate prior percentage cost proxies, and is also highly correlated with various price impact measures. The measure is an analytic measure that requires only daily return observations (i.e. not a market index) and the fraction of zero return days relative to total trading days for the asset. The measure can be calculated for period t as, $FHT_t = 2\sigma_t \mathrm{N}^{-1}[(1+Z_t)/2]$ where σ_t is the standard deviation of the asset's daily returns over the period; Z_t is the number of zero return days as a fraction of total trading days during the period; and N^{-1} is the inverse function of the cumulative normal distribution.

Depth and price impact measures

As the spread measures typically measure the implicit cost of trading a small quantity at the best prevailing quotes, Harris (1990) proposes a second important aspect of liquidity; *depth*. In recent years the availability of order-level data from limit order markets has made it possible to measure depth more accurately. However, direct depth measures typically involve massive amounts of data, especially due to the tremendous growth in high frequency trading activity recent years. Since this DP does not apply order level data, the EBA will instead focus on metrics applied in the literature that are tailored to provide implicit measures of depth.

A key element in asymmetric information models is that trades convey information, and the quicker prices reflect new information (private and public) the more efficient are prices. Typically, the speed of price discovery, and hence price efficiency, is closely linked to liquidity. As discussed above, Lesmond, Ogden, and Trzcinka (1999) suggest that assets that have higher transaction costs also have less informationally efficient prices. An important distinction is between informed and uninformed trades, and is a key to measuring the price impact of trades. Informed trades should adjust prices *permanently* to new equilibrium levels while uninformed trades caused by e.g. traders receiving idiosyncratic shocks that trigger trades should generate temporary price impacts where prices quickly revert to the pre-trade equilibrium price. This distinction forms the basis for several empirical models of price discovery that aim at quantifying price impacts. One important contribution in this regard is Hasbrouck (1991) who proposes that the interactions of trades and quote revisions be modelled as a vector autoregressive system. Without going into the details of his model, the main results can be summarized as follows; (i) a trade's full price impact is not instantaneous; (ii) the impact is a positive and concave function of the trade size; (iii) large trades widens the spread and produce larger price impacts; and finally (iv) information asymmetries are more significant for smaller firms. In a more recent paper Hasbrouck (2009) examines low frequency proxies of effective cost estimators for the US equity markets, where he proposes an intraday price impact measure that is more applicable to this DP. He proposes that the representative price impact (λ_i) of trading in a stock i can be estimated as, $\Delta p_{it} = \lambda_i S_{it} + u_{it}$ where S_{it} is the aggregate signed square-root dollar volume during window t, measured as $S_{it} = \sum(q_t\sqrt{|v_t|})$ where v_k is trading volume (in currency) executed during window t. The length of the aggregation window, t, used in Hasbrouck (2009) is 5 minutes.

There are also several low frequency price impact measures that are typically applied when researchers use daily data. One widely applied measure is the Amihud (2002) illiquidity ratio (ILR). While ILR can be applied to intraday data, it is typically considered a low frequency measure of illiquidity. The ILR is simply calculated as $ILR_n = 1/D_n \sum_{k=1}^{n}[|r_k|/v_k]$ where $|r_k|$ is the absolute return of the asset over time window k, v_k is the currency volume traded over window k, and D_n just reflect the number of windows n (which could be number of hours or days). The ILR is typically scaled up by a factor of 10^6 for practical purposes. Intuitively, the ILR capture how much the price of an asset moves (in either direction) per currency unit of trade. On average, the ILR measure reflect how sensitive the price is to trade volume, and assets with a high ILR are less liquid (have greater price impact) than assets with a low ILR. One issue with the ILR is that as the denominator gets close to zero, the ILR measure goes to infinity. Hence, especially when applying this measure to less traded stocks, or at the intraday frequency, one may experience large outliers.

Price- and liquidity reversal

Another dimension that Harris (1990) proposes as an important characteristic of liquid assets is how quickly the price reverts back to the equilibrium price after large liquidity trades. As discussed earlier, this may also be defined as how quickly liquidity supply replenishes after a large liquidity demand has been filled. To measure the resiliency of an asset is relatively challenging, and the literature is relatively scarce. The papers that attempt to estimate the resiliency are typically focusing on electronic limit order markets. Degryse et al. (2005) studies the resiliency of stocks traded on the Paris Bourse by examining the price impact of aggressive order flow (marketable limit orders that demand liquidity) and how prices recover after aggressive trades. They find that the Paris Bourse stocks recover quickly, within just a few quote updates. In another paper Large (2007) measures resiliency as how long it takes for liquidity to replenish after aggressive trades. Moreover, he studies the time it takes for the limit order book to return to its normal shape after large trades. As this estimator requires detailed order level data, the EBA does not go into the details as it will not be applicable for this paper. However, other measures are available. One example is Pastor and Stambaugh (2003), who propose that stock market liquidity can be measured by regressing next period returns for an asset on the signed current period return multiplied by the currency volume of trades in the asset. The authors obtain a monthly measure $(\gamma_{i,t})$ from the regression, $r^e_{i,d+1,t} = \theta_{i,t} + \phi_{i,t} r_{i,d,t} + \gamma_{i,t} sign(r^e_{i,d,t}) \cdot v_{i,d,t} + \epsilon_{i,d+1,t}$, where $r^e_{i,d+1,t}$ is the excess return on asset i on day d in month t; $v_{i,d,t}$ is the currency volume traded in asset i on day d in month t. While their measure is essentially a measure of price impact, it has a flavour of resiliency as it instead of measuring the direct price impact of trades it captures how much the price reverts to get back to its equilibrium level. It should be noted however that the authors themselves warn that their measure seems too noisy to be useful at the individual asset level due to large sampling errors, and is most applicable to measure market-wide liquidity for an asset class.

Other methods

There is also a part of the literature on market liquidity measurement that proposes that one looks at common (latent) factors across different measures of liquidity. As such, these methods attempt to reduce the universe of liquidity metrics across several liquidity dimensions to a few metrics.

Several papers study whether liquidity risk is systematic and whether that systematic risk is priced in equity markets. Among these are Chordia, Roll, and Subrahmanyam (2000) and Hasbrouck and Seppi (2001) which demonstrate that liquidity has a common systematic factor. One important contribution to this literature is Korajczyk and Sadka (2007) who propose using principal component analysis to extract common liquidity factors from a large set of different liquidity measures. In their paper they extract three common factors from a set of liquidity measures containing ILR, turnover, quoted spread (QS) effective spread (ES), four price impact measures and a measure of order imbalance measured as the ratio of the net sum of signed trading volume over the month scaled by the number of shares outstanding. They show that shocks to assets' liquidity have a common component across measures which account for most of the explained variation in individual liquidity measures. The main purpose of their analysis is to examine whether liquidity is a priced risk factor in stock market returns, and find that the across-measure systematic liquidity factor is priced. A recent application of principal component methods to the US corporate bond market is in Dick-Nielsen, Feldhutter and Lando (2012) which is discussed below.

Annex 2: Literature on the liquidity of different asset classes

The discussion in Annex 1 mapped out some common liquidity measures applied in the literature. While several of these measures initially were tailored to and assessed for equity markets, they have also been applied to other asset classes. For the purpose of this DP it is very useful to obtain an overview of which measures have successfully been applied to various asset classes. It will also be useful to get an overview of the typical liquidity estimates obtained for different asset classes, both as a benchmark against which the results obtained in this DP can be compared, and to examine how different asset classes have been ranked relative to each other for other markets and other periods. Note that there are several limitations in the literature, largely due to data availability. While studies for equity markets exist for a wide range of markets, a large part of the literature on corporate and government bonds as well as for other asset classes are concentrated on US data.

Corporate bonds

Historically corporate bonds have largely been traded over the counter, and the data availability has been relatively scarce. There are however several studies on the liquidity of the corporate bond market in the US that uses different low frequency data sources. In a recent paper, Chen et al (2007), examines various liquidity measures for a sample of more than 4000 US corporate bonds spanning a wide range of bonds from investment grade to speculative categories. Their main data sources are Bloomberg and Datastream which they use to calculate several liquidity measures for individual bonds, and groups of bonds. The first measure they calculate is the proportional bid ask spread (using Bloomberg data). Due to the low frequency (quarterly) nature of their data, they also apply the spread proxies discussed earlier in this section. The two additional measures they calculate are the percentage zero return days measure (*Zeros*), and the Lesmond et al. (1999) LOT. Overall, they show that their estimates of liquidity costs increase as credit rating worsens. With respect to proportional spreads, they report average spreads of 0.25% for AAA, to 0.31% for BBB and 0.77% for CCC to D for bonds with maturities between 1 and 7 years. For the LOT and Zeros measure, they estimate a significantly larger difference in liquidity costs between investment grade and speculative grade bonds.

In the US, the Financial Industry Regulatory Authority's (FINRA) TRACE is responsible for operating the reporting and dissemination facility for over-the-counter corporate bond trades. The data starts in 2002, and the reporting requirements were gradually increased until 2005 when about 99% of all public transactions are captured. This dataset has been applied in several more recent studies examining the liquidity of the US corporate bond market.

One important paper that exploits the TRACE transactions data is Bao et al (2011) who studies the US corporate bond market for the period 2003 through 2007. They show that the illiquidity of US corporate bonds is substantial and significantly greater than what can be explained by bid ask spreads. Furthermore, they establish a strong link between bond illiquidity and bond prices and show that changes in market wide illiquidity explain a substantial part of the time variation in yield spreads of high-rated bonds.

The paper also shows that the liquidity risk component overshadows the credit risk component. The illiquidity measure they apply is calculated as; $\gamma = -cov(\Delta p_t, \Delta p_{t+1})$ where $\Delta p_t = p_t - p_{t-1}$, and prices are in natural logarithms. While their measure looks very similar to the Roll (1984) measure, the economic intuition is different. While the Roll (1984) estimator exploits the negative autocorrelation in trade prices caused by the bid ask bounce, the measure by Bao et al (2011) is motivated by the fact that the transitory impact of liquidity should be uncorrelated with the fundamental value of the asset. Hence, their measure is closely related to the Pastor and Stambaugh (2003) measure discussed earlier, as it measures the illiquidity as the size of price reversals. More illiquid stocks are expected to have a stronger *negative* covariance of consecutive price changes (greater reversals), which would imply a larger positive γ given their specification of γ above. In terms of magnitude, their estimate of γ has a cross-sectional average of 0.58 using the full time-series sample.

To compare their price reversal measure against other metrics, Bao et al (2011) also calculate the Roll (1984) measure for their sample bonds. Furthermore, they also compare their results with another paper by Edwards, Harris, and Piwowar (2007) who uses a more detailed version of the TRACE dataset which also includes information on the side on which the dealer participated. This makes them able to determine whether the trade was initiated by a buyer or seller, such that they can directly measure the effective spread. Bao et al (2011) compare their Roll measure with the effective spreads in Edwards, Harris, and Piwowar (2007) for various trade sizes. Interestingly, in both studies the implicit and effective spreads decline with trade size. E.g. for trade sizes in the range of $7.5k to $15k, the average implicit spread is 1.98% and the effective spreads is 1.42%, while for trade sizes above $750k, the implicit spread is 0.52% and the effective spread is 0.18%.

The most extensive study of the liquidity of the European corporate bond market is a commissioned report produced by Biais et al. (2006) for the City of London on the transparency, liquidity and efficiency of the European corporate bond market. This report surveys the empirical literature on the liquidity of corporate bonds and also provides empirical evidence for the European market using International Index Company (IIC) data containing daily end-of-day bid and ask quotes in the iBoxx index. They examine euro- and sterling-denominated corporate bonds for the period 2003-2005, and the report contains a wide range of statistics across various characteristics. While it is unsure how representative their results are for today's market, they find that, after controlling for sample period and credit risk, the effective spreads in euro-denominated bonds are lower than their US counterparts. Moreover, they find that the effective half spread for trades above one million Euros is 0.049%. This is significantly lower that the results in Goldstein et al. (2005) for the US market who find that the half spread is 0.22% for transactions above one million USD. Interestingly, the spread estimates for the US corporate bond market is similar to the results in Chen et al (2007) discussed earlier. Biais et al. (2006) suggests some explanations for the difference between the US and European bond markets. Since the advent of the Euro, the European bond market has become integrated with investors from all European countries trading in the same market. This large pool of buyers attracts sell-side intermediation. As such, they argue that their results suggest that the supply of liquidity in the euro-denominated bond market is rather competitive, which drives spreads down.

Since this DP is about identifying which assets have the ability to retain their liquidity during stressful periods, a recent paper by Dick-Nielsen, Feldhutter and Lando (2012) is particularly enlightening. They perform an extensive study of the corporate bond market liquidity in the US for the period 2005 through 2009. For this purpose, they calculate several liquidity measures including a Amihud (2002) ILR, the zero trading days, and the Roll (1984) implicit spread measure among others. They also extract principal components from a set of eight different liquidity and activity measures. Their overall results suggest that bond market liquidity worsened dramatically during the subprime crisis. They also find that their common liquidity factor derived from a principal component analysis is superior to earlier measures when it comes to explaining variations in yield spreads.

Houweling, Mentink and Vorst (2005) take a different approach by studying bond and issuer specific characteristics that are related to liquidity. Motivated by the fact that for corporate bonds, most transactions occur on the over-the-counter market, direct liquidity measures (based on transaction data) are often not reliable and difficult to obtain, and researchers need to rely on other proxies of liquidity. They examine a set of bond and issuer specific characteristics that have been used to proxy for corporate bond liquidity and liquidity risk in other papers. The measures they examine are (i) issued amount, (ii) whether the bond is listed on a stock exchange, (iii) whether the bond is denominated in euros or in one of the legacy currencies, (iv) if the bond is on-the-run, (v) age, (vi) missing prices (as a proxy for no-trades), (vii) yield volatility, (viii) number of contributors (proxy for competition) and (ix) yield dispersion. Their null hypothesis that liquidity risk is not priced in their sample of euro corporate bonds is rejected for eight out of nine liquidity proxies. The only proxy that they do not find support for relating to liquidity risk is the number of contributors. Overall they find a significant liquidity premium, ranging from 13 to 23 basis points. Another important contribution of their paper is that the vast majority of empirical papers on sovereign and corporate bond liquidity studied data from the United States and relatively little is known about the extent to which these results apply to the euro market. Although their paper does not give any direct measures on corporate bond liquidity, this is one of the first papers that study the effects of corporate bond liquidity on the bond yields in the European markets.

Government bonds

Also for government securities, most empirical studies focus on the US market. A much cited study on the liquidity of the US treasury market is Fleming (2003). His paper estimates and evaluates a wide range of liquidity measures using high frequency data from the interdealer market (GovPX data). Measures examined are trading volume, trading frequency, bid ask spreads, quote sizes, trade sizes and price impact coefficients. He compares various measures against each other to provide insights to how liquidity can be best measured and tracked. One main result in this regard is that the bid ask spread is found to be a good measure of treasury market liquidity and is highly correlated with a more sophisticated price impact measure (the coefficient from a regression of price changes on signed volume and trades). Interestingly he finds that trading volume and trading activity, in particular, are found to be weak proxies for market liquidity as both high and low levels of trading activity are associated with periods of poor liquidity. This is consistent with the results and arguments in Aitken and Comerton-Forde (2003) for the equity market.

For US government bonds, a recent paper by Goyenko, Subrahmanyam and Ukhov (2011) examine how liquidity varies across different maturities and also between on-the-run and off-the-run bonds. Their sample period spans more than 35 years covering the period from November 1967 – December 2005. They use data from the Center for Research in Security Prices (CRSP) daily Treasury Quotes file containing bid and ask prices for Treasury fixed income securities for maturities ranging from 3 months up to 30 years. The main liquidity measure they apply is the proportional quoted bid ask spread. Their main results are that spreads increases in recessions across all maturities, both for on-and off-the-run bonds. However, they find that the increase in spreads is especially large for long term bonds. They argue that these results suggest that investors shift into short term bonds during recessions. The average proportional spread for medium term US government off-the-run bonds is 0.11%, which is much lower than what is found for US corporate bonds in e.g. Bao et al (2011) reported earlier. When looking separately at US recession periods and non-recession periods (as classified by NBER), their spread estimates are 0.149% during recessions and 0.101% during non-recessions. For short term bonds (Treasury bills) the whole sample average proportional spread is 0.025%, with an average spread of 0.049% during recessions and 0.002% during non-recession periods.

For the European market a similar commissioned report as the one produced by Biais et al. (2006) on the corporate bond market was produced for the European government bond market. This report was produced by Dunne et al. (2006). The empirical analysis in the report uses several data sources. For the euro-denominated European government bond market they use detailed data for the limit order book and transactions from the MTS trading platform covering selected months over the period 2003 through 2005. They also apply various datasets for the US treasury market (e.g. Cantor Market Data, BrokerTec and GovPX) to compare the liquidity of the European versus the US government bond market. While they also examine a wide range of other characteristics, the liquidity variables they calculate are the effective spread, the steepness of the order-book, the trade size, the liquidity (depth) at the best bid and ask quotes and the depth at the best three quotes. Overall they find that the median effective spreads for the European MTS sample is significantly higher than for the US sample. They suggest that this can be explained by the relatively small size of issuance, the fragmented nature of the euro-denominated markets, and the fact that there are fewer primary dealers providing liquidity across a larger number of issues. For short maturity bonds, the median effective spread for European issues is more than double of the US counterparts. These results are also largely mirrored for medium- and long maturities.

Covered Bonds

The literature studying the liquidity of covered bonds is much scarcer than for the above asset classes. However, a recent study by Dick-Nielsen, Gyntelberg and Sangill (2012) examines the secondary market liquidity of government and covered bonds in Denmark before, during and after the 2008 financial crisis. They apply a liquidity measure that is closely related to the Amihud (2002) ILR measure, but modified in a manner demonstrated by Dick-Nielsen, Feldhutter and Lando (2012) to be a good proxy for US corporate bond liquidity. The modified ILR measure is calculated as, $PI_{t,i,k} = |\mathrm{p}_{\mathrm{t,i,k}} - \mathrm{p}_{\mathrm{t,i-1,k}}| / \mathrm{p}_{\mathrm{t,i-1,k}}$, where i refers to the ith transaction on day t in bond k. Hence, the measure captures how much the price moves in either direction in response to a trade. The study finds that the liquidity of both government and covered bonds worsened during the crisis period. Whilst government bonds outperformed covered bonds before the crisis, the liquidity of the two instruments was broadly similar during the crisis. Therefore the liquidity of covered bonds worsened less than government bonds during the crisis, although overall liquidity conditions were similar across the two markets.

Equities

The literature on liquidity is most developed for equities markets due to the superior data availability both with respect to readily available very detailed intraday order level data for many markets, the time series length of the data, and also the large theoretical equity market microstructure literature. O'Hara (1995) provides a study of the theoretical microstructure literature while Madhavan (2000), Biais, Glosten and Spatt (2005) and Vayanos and Wang (2012) surveys both the theoretical and empirical literature. Most, if not all, of market liquidity measures that are being applied to other asset classes were initially developed for equities. The literature on equity market liquidity is large and we the EBA limits the review to some key articles. The literature can generally be divided in two main parts; (a) studies that examine how liquidity can be measured, and (b) studies on the asset pricing implications of liquidity and liquidity risk (applying various liquidity measures). As the first part of the literature is the one most relevant for this paper, we will disregard the second part (asset pricing) of the literature, and focus on the more recent studies.

A much cited paper that that examines the development in US equity market liquidity using a century of data is Jones (2002). He compiles a time series of bid ask spreads on Dow Jones Stocks covering the years 1900 through 2000. He finds that the average quoted and proportional bid ask spreads have decreased over the sample period, a result also documented in Hasbrouck (2009) among others. The proportional spread estimates in Jones (2002) suggest that the average proportional spread has fallen from around 0.7% in the early 1900s to about 0.2% in 2000. Interestingly also he finds that the annual share turnover was much higher early in the sample (about 200% in 1900) than in the more recent part of the sample (50% in 1990), although there is an increasing trend from the 1970s. Another result in Jones (2002) is that equity market liquidity has a cyclical component and worsens in periods of market stress. The results in Næs, Skjeltorp and Ødegaard (2011) strongly suggest that equity market liquidity in the US (1947-2008) and Norway (1980-2008) has a cyclical component related to the business cycle. Moreover a worsening of equity market liquidity is found to be a strong and stable predictor of NBER recession periods and the business cycle. The business cycle component of market liquidity is most pronounced for stocks with low market capitalizations. Using detailed equity ownership data, Næs et al (2011) also find that investors shift their portfolios both within equities and out of equities during economic downturns, and that this is consistent to a flight to quality. The liquidity measures applied in the above studies are quoted- and proportional spreads, the Hasbrouck (2009) effective cost measure, the Amihud (2002) illiquidity ratio (ILR), the Lesmond et. al (1999) measure (LOT).

More recent studies on equity market liquidity uses detailed high frequency order book data to provide more accurate measures of liquidity. Also, a large part of this recent empirical literature tries to identify which low frequency measures that best proxy for their high frequency counterparts, and also to analyse the liquidity of markets outside the US. A recent paper by Fong, Holden and Trzcinka (2011) examines the liquidity of more than 18,000 stocks listed on 43 exchanges around the world. They examine 19 low frequency measures over a sample period from 1997 through 2007. Overall they find that both price impacts and effective spreads have fallen across most markets over their sample period. An important contribution in Fong et al (2011) is that they propose a new low frequency proxy for effective spread (FHT) which is both simple to calculate and is shown to be superior to most other percent cost proxies.

Commodities

Since Gold is defined as a potential LCR eligible asset class in Art. 481 paragraph 2 of the most recent CRR, it is useful to review the literature assessing the market liquidity of commodities markets. While this literature is very scarce, a recent paper by Marshall, Nguyen and Visaltanachoti (2011) provides a broad analysis applying various liquidity measures to a wide range of commodities, including gold. They also evaluate which liquidity measure best captures the liquidity of commodities markets by comparing high frequency benchmarks with low frequency proxies similar to Goyenko et al (2009) and Fong et.al (2010) for equities. Their study examine commodity futures covering six energy commodities, eight agricultural commodities, three livestock commodities, five industrial metals and two precious metals. These are the twenty four commodities that comprise the S&P Goldman Sachs Commodity Index (S&P GSCI). Their main data source is the Thomson Reuters Tick History database covering both open-outcry and electronic trading. They also examine daily commodity data obtained from Thomson Reuters Datastream. The paper examines a total of 17 low frequency (daily data) liquidity proxies and three high frequency benchmarks (tick data). The main results in their study is that the Amihud (2002) ILR measure has the highest correlation with the high frequency benchmarks across all low-frequency liquidity measures. Interestingly, their results find support for earlier findings by Ferguson and Mann (2001) that the Roll (1984) effective spread estimator is a poor proxy for commodity liquidity. With respect to the liquidity of different commodities, their results strongly suggest that precious metals (gold and silver) are a highly liquid commodity class. Both bid ask spread measures, price impact measures and resiliency measures show that gold is consistently the most liquid commodity.

Annex 3: MiFID Data Fields

This section summarizes the common reporting items on security trades due to the MiFID directive. To the EBA's understanding the listed items contain the minimum reporting requirements under MiFID.

1. Technical Reporting Firm Identification

A technical reporting firm is an organisation which is approved to send transaction reports to the authority on the behalf of a MiFID investment firm or itself.

The input is mandatory and must be a valid 11 characters ISO 9362 SWIFT/Bank identifier code (BIC).

2. Reporting firm identification

BIC code of the MiFID investment firm which executed the transaction.

The input is mandatory and must be a valid 11 characters ISO 9362 SWIFT/Bank identifier code (BIC).

3. Transaction Reference number

A unique identification number for the transaction provided by the MiFID investment firm or a third party reporting on its behalf. An alphanumeric field up to 40 characters for the unique transaction reference number for each transaction reported by a particular firm. The value must be unique per Reporting Firm.

This field will be used as a reference to the transaction in all communication between the authority and the reporting firm. How to populate the field is free as long as the number will stay unique per Reporting Firm. One way of populating the field could be to use the data combined with a sequence number.

4. Trading date time

The date, time and time zone when the trade was executed.

5. Buy/Sell indicator

Identifies whether the transaction was a buy or a sell from the perspective of the reporting investment firm if acting as principal, or of the client if acting as an agent.

B = Buy. S = Sell.

6. Trading Capacity

The trading capacity of the MiFID investment firm executing the transaction.

The market transaction is performed as of: Own accord (P), own account as market maker (M), own account as agent for a customer (C), own account as agent for a customer spread over several days e.g. warehousing (W), agent for a client (A).

Instead of using all 5 values it is sufficient to use 'On its own account (either on its own behalf or on behalf of a client' = P (Principal) and 'For the account, and on behalf, of a client' = A (Agent). In some jurisdictions only P and A are valid.

7. Instrument Identification

The ISIN code that uniquely identifies the financial instrument which is the subject of the transaction. Must be a valid ISO 6166 ISIN code.

8. Unit price

The price per security excluding commission. In the case of a debt instrument, the price should be expressed as a percentage and excluding accrued interest (clean price).

Negative values are not allowed. It express whether:

The price in percentage in case of a debt instrument, or
The unit price of a security, or
The price of one derivative contract.
Percentage values populates the field with integers and decimals, e.g. 12.34% is populating the field with 12.34.

For bonds, the unit price field should be populated with the relative price expressed as a percentage.

9. Price notation

The ISO code of the currency in which the price is expressed or the currency of the nominal value in case of a price expressed in percentage.

Must be a valid ISO 4217 currency value (pre-euro ISO currency codes are also allowed for bonds)

10. Quantity

The number of units of the financial instrument, the total nominal value of bonds, or the number of derivative contracts included in the transaction.

Negative values or zero are not allowed.

11. Counterparty code & Counterparty code Type

Identification of the counterparty of the transaction. Depending on the counterparty, this field contains:

Where the counterparty is a MiFID investment firm, the full 11 character BIC code is used to identify the investment firm.
Where the counterparty is a regulated market or MTF the field should be populated with the MIC code of the trading venue
Where the counterparty is a central counterparty the field should be the BIC code of the central counterparty.

Where the counterparty is not a MiFID investment firm, a regulated market, an MTF or entity acting as a central counterparty, the field should be populated with an internal code. In theis case this counterparty codetype should be ‘C’ for ‘Customer/client’.

12. Venue code type and venue identification

Identification of the venue where the transaction was executed. Atrading venue is an MTF, regulated market (RM) or Systemic Internalizer (SI). The four character SWIFT MIC code (ISO 10383) should be used when the venue is an MTF or a regulated market. If the venue is an SI the BIC code should be used. If the transaction is made off market, the ‘XOFF’ should be used.

The MIC shall identify the actual venue and not the market operator.

Annex 4: Examples of Characteristics Potentially Explaining Liquidity Metrics

Characteristics that refer to the market structure:

- **Large number of market makers**: this generates a steady supply and demand for the asset in the market;
- **Traded via additional platforms and markets** (on top of the recognised exchange): this generates additional scrutiny and broadens the market;
- **Wide range of potential buyers**: the asset is permissible under mandates of many investor classes, such as insurance companies, pension funds, endowments;
- **Transparency**: Standardisation, private-sector initiatives, and regulation all contribute to transparency of structural characteristics of assets.

Characteristics specific to the asset:

- **Collateral eligibility**: frequently accepted as collateral for transactions in other assets/derivatives at a wide range of markets, clearing houses, and payment systems;
- **Credit rating:** This is one of the quantitative based liquidity metrics required by the CRR, and by affecting credit quality will have direct implications on liquidity;
- **Issue size:** the outstanding amount of a security available for trade affects the ability to buy and sell the security in large quantities;
- **Remaining time to maturity:** Another of the quantitative based liquidity metrics, time to maturity is likely to affect the price volatility of a security and also affects the number of investor who may be willing to purchase it;
- **Low complexity**: this is hard to capture, but is an important characteristic of liquid assets. To some extent it is captured by (f) to (i) and by the requirement in Art 404 (3) (c);
- **Standardisation**: a high degree of standardisation of typical structures inside a class of assets reduces perceived complexity of products and increases liquidity;
- **Product specific regulation**: Private-sector initiatives provide an alternative to regulation; e.g. the approval by an industry body, the use of master agreements (e.g. ISDA)/contracts for transactions/assets;
- **Proven track record**: A crude but intuitive characteristic is the length of the history of an asset class – a minimum of X years of history as recognised asset class. Financial innovation has proven to be often linked to legal uncertainty, to lack of standardisation, and high complexity, although the minimum length of time applied might be mitigated by other considerations, for instance in the case of new covered bonds frameworks that are based on existing European covered bond legislative frameworks.

In order to test these general explanatory characteristics against quantitative based liquidity metrics, the characteristics will need to be further specified for each asset class.

Explanatory characteristics specific to a single asset class

Sovereigns

- Currency (higher liquidity is expected, if issued in the domestic currency)

Explanatory Characteristics for Covered Bonds

Threshold-criteria of Art. 404(3): UCIT-compliant

Further characteristics to be tested:

- CRD-compliant
- percentage of public placement
- Characteristics of the issuer
- Characteristics of the collateral (type of collateral, LTV, NPL, ongoing valuation, overcollateralization, recoverability, geographical distribution of cover pool, allowed exchange assets, derivatives and securitizations in cover pool)

Explanatory Characteristics for ABS

- Type of underlying assets (RMBS, CMBS, CP, e.a.)
- senior tranches vs. junior tranches
- percentage of public placement

Explanatory Characteristics for RMBS

- characteristics of the underlying asset pool
- 'risk retention' regulation

Explanatory Characteristics for Corporate Bonds

Threshold related to the specific LCR-scenario: not issued by a financial

Explanatory Characteristics for Equities

Threshold criteria related to the specific LCR-scenario: not issued by a financial

- exchange traded and centrally cleared
- constituent of a major stock index

Annex 5: Survey of liquidity metrics

#	Metrics	Formula	Concept	Input
1	Trading volume	$V(\Delta t)=\sum_{i=1}^{N_{\Delta t}} q_i$	Sum the number of securities traded during a time interval Δt.	Trades sizes
2	Turnover	$T(\Delta t)=\sum_{i=1}^{N_{\Delta t}} p_i * q_i$	Sum the number of trade prices (trade size * trade price) during a time interval Δt.	Trades sizes and prices
3	Depth or Quantity depth	$D(t)=q_{ask}(t)+q_{bid}(t)$	Sum best ask and bid volumes in the order book at time *t.*	Best ask and bid volumes
4	Log depth	$D_{log}(t)=\ln(q_{ask}(t)*q_{bid}(t))$	Sum of the natural logarithm of the best ask and of the best bid volumes in the order book at time *t.*	Best ask and bid volumes
5	Dollar depth	$DD(t)=\frac{q_{ask}(t)*p_{ask}(t)+q_{bid}(t)*p_{bid}(t)}{2}$	Arithmetic average of the product of the best ask price and its respective volume and the best bid price and its respective volume in the order book at time *t.*	Best ask and bid prices and volumes
6	Number of transactions per time unit	$N(\Delta t)$	It counts the number of trades during time interval Δt.	Order book
7	Number of orders per time unit	$O(\Delta t)$	It counts the number of orders inserted into the order book during time interval Δt.	Order book
8	Absolute spread (or dollar spread)	$S(t)=p_{ask}(t)-p_{bid}(t)$	Difference between the lowest ask and the highest bid prices in the order book at time *t*.	Lowest ask and the highest bid prices at time *t*
9	Log absolute spread	$S_{log}(t)=\ln\left(p_{ask}(t)-p_{bid}(t)\right)$	Natural logarithm of absolute spread at time *t*.	Lowest ask and the highest bid prices at time *t*
10	Relative or proportional spread calculated with mid price	$S_m(t)=\frac{\left(p_{ask}(t)-p_{bid}(t)\right)}{p_{mid}(t)}=\frac{2*\left(p_{ask}(t)-p_{bid}(t)\right)}{\left(p_{ask}(t)+p_{bid}(t)\right)}$	Absolute spread at time *t* divided by the mid-price at time *t*.	Lowest ask and the highest bid prices at time *t*
11	Relative spread calculated with last price	$S_{p(t)}(t)=\frac{\left(p_{ask}(t)-p_{bid}(t)\right)}{p(t)}$	Absolute spread at time *t* divided by the last paid price before time *t*.	Lowest ask and the highest bid prices and the last paid price before time *t* / Order book
12	Relative spread of log prices	$SRelLog(t)=\ln\left(\frac{p_{ask}(t)}{p_{bid}(t)}\right)$	Difference of natural logarithms of the lowest ask and of the highest bid prices in the order book at time *t*.	Lowest ask and the highest bid prices at time *t*

13	Effective spread	$Seff\ (t) = \lvert p(t) - p_{mid}(t) \rvert = \left\lvert p(t) - \left(\frac{p_{ask}(t) + p_{bid}(t)}{2} \right) \right\rvert$	Difference between the last paid price before time *t* and the mid-price at time *t*.	Lowest ask and the highest bid prices and the last paid price before time *t* / Order book
14	Relative effective spread calculated with mid price	$SeffRelMid(t) = \frac{\lvert p(t) - p_{mid}(t) \rvert}{p_{mid}(t)} = \frac{\left\lvert p(t) - \left(\frac{p_{ask}(t) + p_{bid}(t)}{2} \right) \right\rvert}{\left(\frac{p_{ask}(t) + p_{bid}(t)}{2} \right)}$	Effective spread at time *t* divided by the mid-price at time *t*.	Lowest ask and the highest bid prices and the last paid price before time *t* / Order book
15	Relative effective spread calculated with last price	$SeffRelLast(t) = \frac{\lvert p(t) - p_{mid}(t) \rvert}{p(t)} = \frac{\left\lvert p(t) - \left(\frac{p_{ask}(t) + p_{bid}(t)}{2} \right) \right\rvert}{p(t)}$	Effective spread at time *t* divided by the last price at time *t*.	Lowest ask and the highest bid prices and the last paid price before time *t* / Order book
16	Quote slope	$QS(t) = \frac{S(t)}{D_{log}(t)} = \frac{(p_{ask}(t) - p_{bid}(t))}{(\ln(q_{ask}(t)) + \ln(q_{bid}(t)))}$	Absolute spread divided by the Log depth.	Lowest ask and highest bid prices and their respective volumes at time *t*
17	Liquidity ratio 1 (Baker (1996)) (or Amivest liquidity ratio)	$LR_1(t) = \frac{T(\Delta t)}{\lvert r(\Delta t) \rvert}$	Turnover divided by the return during time interval Δt.	Trades sizes and prices and asset return during time interval Δt.
18	Liquidity ratio 2 (Ranaldo (2000))	$LR_2(t) = \frac{LR_1(t)}{(N_e - N_o)}$	LR1 divided by the difference between the total number of securities and the number owned by the firm during time interval Δt.	Trades sizes and prices and asset return during time interval Δt and total number securities available and owned by the firm
19	Order ratio	$OR(t) = \frac{q_{bid}(t) - q_{ask}(t)}{T(\Delta t)}$	Difference between the best bid and the best ask volumes at time *t* scaled by the turnover during time interval *t*.	Best bid and the best ask volumes and trades sizes and prices.
20	Market impact	$MI(t,T) = p_{ask}(t,T) - p_{bid}(t,T)$	Difference between the ask and the bid price in the order book at time *t* for a certain turnover *T* to be generated.	Order book
21	Depth for price impact	$DI_{ask}(t, p_{ask}(t) - p_{mid}(t)) = V_{ask}(t, p_{ask}(t) - p_{mid}(t))$ $DI_{bid}(t, p_{bid}(t) - p_{mid}(t)) = V_{bid}(t, p_{bid}(t) - p_{mid}(t))$	It represents the number of securities *DI* that has to be traded to move the price a certain amount from the quote midpoint.	Order book

22	Price impact	$PI_{ask}(t,q)=\ln\left(\frac{\sum_{k=1}^{K} p_{ask,k}(t)*q_{ask,k}(t)}{q(t)*p_{mid}(t)}\right)$ $PI_{bid}(t,q)=-\ln\left(\frac{\sum_{k=1}^{K} p_{bid,k}(t)*q_{bid,k}(t)}{q(t)*p_{mid}(t)}\right)$ with $q(t)=\sum_{k=1}^{K} q_k(t)$.	PI is calculated on the demand and supply curve. A market order of size *q* is executed at *K* different prices with q_k *securities trading at price* p_k and $q(t)=\sum_{k=1}^{K} q_k(t)$.	Order book
23	Xetra Liquidity Measure (XLM) (weighted spread liquidity measure)	$XLM(n*p_{mid})=\left(\frac{\sum_i (p_{ask}(t,i)*q(t,i))-\sum_i (p_{bid}(t,i)*q(t,i))}{n*p_{mid}}\right)$	The XLM is a weighted spread liquidity measure. It was developed by Deutsche Boerse Group for its electronic platform Xetra. The Xetra platform calculates automatically XLM based on the Xetra electronic book which includes the iceberg orders, trades submitted invisible. The XLM is the average limit-order-volume weighted price of all limit orders, which are required for transacting a specific size, relative to the mid price. The XLM can be seen as the cost of immediate execution of a specific size ($n*p_{mid}$) compared to the mid price. The XLM is very similar to the Price Impact.	Measure provided by Xetra for the Xetra trading platform but can be calculated from the order book (including iceberg orders)
24	Marginal Supply Demand Curve (MSDC)	The Marginal Supply Demand Curve (MSDC) is defined formally as follows: An asset A is a good traded in the market with prices given by a function $x \rightarrow m(x): \Re \setminus \{0\} \rightarrow \Re$ called the Marginal Supply-Demand Curve (MSDC) which satisfies: 1. $m(x_i) \geq m(x_{i+1})$ *if* $x_i < x_{i+1}$ 2. *m(x)* is cadlag (i.e. $\lim_{y \downarrow x} m(y)=m(x)$) for $x<0$ and ladcag (i.e. $\lim_{y \uparrow x} m(y)=m(x)$) for $x>0$	Let m_i represent the prices and Δx_i represent the corresponding maximum sizes (expressed in number of contracts *x*). For instance, suppose that we have to sell a given number of contracts *z* of a certain asset. We list all the bid prices in a decreasing order vector, which lists the prices from the most convenient to the least convenient from our sell point of view. So we will index the quotes accordingly ($m_i \geq m_j$ *if i*	Order book

Let call $m^+=m(0^+)$ the *best bid* and $m^-=m(0^-)$ the *best ask*. The quantity $\delta m= m^+-m^-\geq 0$ is called the *bid-ask spread*.
A necessary assumption is the no arbitrage requirement that any bid lower than any ask prices. Given this assumption, the MSDC is decreasing by construction.

$\leq j$). We will firstly exploit the highest bids by selling amounts $\Delta z_i \leq \Delta x_i$ until $\sum_i \Delta z_i = z$. The net proceed from our sales will be $P=\sum_i m_i \Delta z_i$.
For ask prices, the reasoning is symmetrical and the best quotes will be the lowest.
We can build the MSDC $x \rightarrow m(x)$ by collecting all the prices $m(x)$ available for trades of dx contracts and sorting them by decreasing order in x. We obtain a single decreasing curve with the best ask quotes for buying z contracts in the interval $x \in [-z,0[$ and the best bid quotes for selling z contracts in the interval $x \in]0,z]$.
The MSDC does not only include the bid-ask spread (tightness) information but also the bid-ask depth (depth) information and the demand and supply information (resiliency).

Annex 6: References

Aitken, M. and Carole Comerton-Forde, 2003, 'How should liquidity be measured?', Pacific-Basin Finance Journal, 11, pp. 45-59.

Amihud, Y. and Haim Mendelson, 1991, 'Liquidity, maturity, and the yield on US treasury securities', Journal of Finance, 46, pp.479-486.

Amihud, Y., 2002, 'Illiquidity and stock returns: cross-section and time-series effects', Journal of Financial Markets, 5, pp. 31-56.

Amihud, Y., Haim Mendelson, and Lasse Pedersen, 2005, 'Liquidity and Asset Prices', Foundations and Trends in Finance, 1, pp. 269-364.

Bao, J., Jun Pan and Jiang Wang, 2011, 'The Illiquidity of Corporate Bonds', 66, The Journal of Finance, pp. 911-946.

Biais, B., Fany Declerck, James Dow, Richard Portes, Ernst-Ludwig vin Thadden, 2006, 'European Corporate Bond Markets: transparency, liquidity, efficiency', Centre for Economic Policy Research (CEPR) http://faculty.london.edu/rportes/TT%20CorporateFULL2.pdf

Biais, B., Larry Glosten and Chester Spatt, 2005, 'Market microstructure: A survey of microfoundations, empirical results, and policy implications.', Journal of Financial Markets, 8, pp.217-264.

Chen, L., D.A. Lesmond and Jason Wei, 2007, 'Corporate Yield Spreads and Bond Liquidity', Journal of Finance, 62, pp.119-149.

Chordia, T., Richard Roll, Subrahmanyam, A., 2000, 'Commonality in liquidity'. Journal of Financial Economics, 56, pp. 3–28.

Chordia, T., Asani Sarkar and Avanidhar Subrahmanyam, 2005, 'An Empirical Analysis of Stock and Bond Market Liquidity', Review of Financial Studies, 18, pp. 85-129.

Degryse, H., Frank De Jong, M. V. Ravenswaaij, and Gunter Wuyts, 2005, 'Aggressive orders and the
resiliency of a limit order market.', Review of Finance, 9, pp. 201–242.

Dick-Nielsen, J., P. Feldhutter, and D. Lando, 2012, 'Corporate bond liquidity before and after the on-set of the subprime crisis', Journal of Financial Economics, 103, 471-492.

Dick-Nielsen, J., Jacob Gyntelberg, and Thomas Sangill, 2012, 'Liquidity in Government versus Covered Bond Markets', Danmarks Nationalbank Working Papers, n.83.

Dufour, A. and Robert F. Engle, 2000, ‘Time and the Price Impact of a Trade’, 55, pp. 2467-2498.

Duffie, D., Nicolae Gârleanu and Lasse Heje Pedersen, 2007, ‘Valuation in Over-the-Counter Markets’, Review of Financial Studies, 20, pp.1865-1900.

Dunne, P., Michael Moore and Richard Portes, 2006, ‘European Government Bond Markets: transparency, liquidity, efficiency’, Center for Economic Policy Research (CEPR).

Edwards, A. K., Lawrence E. Harris and Michael S. Piwowar, 207, ‘Corporate Bond Market Transaction Costs and Transparency’, LXII, pp. 1421-1451.

Ellis, K., Roni Michaely and Maureen O'Hara, 2000, ‘The Accuracy of Trade Classification Rules: Evidence from Nasdaq’, Journal of Financial and Quantitative Analysis, 35, pp 529-551.

Ferguson, M. F. and Steven C. Mann, 2001, ‘Execution Costs and Their Intraday Variation in Futures Markets’, Journal of Business, 74, pp. 125-160.

Fong, K., Craig W. Holden, Charles A. Trzcinka, 2011, ‘What Are The Best Liquidity Proxies For Global Research?’, Working Paper, Available at SSRN: http://ssrn.com/abstract=1558447.

Fleming, M. 2003, ‘Measuring Treasury Market Liquidity’, FRBNY Economic Policy Review. http://www.newyorkfed.org/research/epr/03v09n3/0309flem.pdf

Glosten, L. R. and Paul R. Milgrom, 1985, ‘Bid, Ask and Transaction Prices in a Specialist Market with Heterogenously Informed Traders’, Journal of Financial Economics, 14, 1985, pp. 71-100.

Goldstein, M. A., Edith S. Hotchkiss and Erik R. Sirri, 2007, ‘Transparency and Liquidity: A Controlled Experiment on Corporate Bonds’, Review of Financial Studies, 20, 235-273.

Goyenko, R., Avanidhar Subrahmanyam, and Andrey Ukhov, 2011, ‘The Term Structure of Bond Market Liquidity and Its Implications for Expected Bond Returns’, Journal of Financial and Quantitative Analysis, 46, 111-139.

Harris, L., 1990, Liquidity, ‘Trading Rules, and Electronic Trading Systems’, New York University Salomon Center Monograph Series in Finance, Monograph # 1990-4.

Hasbrouck, J., 1991, ‘Measuring the Information Content of Stock Trades’, Journal of Finance, 46, pp.179-207.

Hasbrouck, J., 2009, ‘Trading Costs and Returns for U.S. Equitites: Estimating Effective Costs from Daily Data’, 2009, 64, pp. 1445-1477.

Hasbrouck, J., Duane J. Seppi, 2001, ‘Common factors in prices, order flows, and liquidity. Journal of Financial Economics, 59, pp. 383–411.
Houweling, P., Albert Mentink and Ton Vorst, 2005, ‘Comparing possible proxies of corporate bond liquidity’, Journal of Banking and Finance, 29, pp. 1331-1358.

Huang R. D., and H. R. Stoll, 1997, ‘The components of the bid-ask spread: A general approach’, The Review of Financial Studies 10, pp. 995-1034.

Keynes, J. M., 1930, Treatise on Money, Vol. II, p. 67 (Macmillan, London).

Korajczyk, R. A. and Ronnie Sadka, 2008, ‘Pricing the commonality across alternative measures of liquidity’, Journal of Financial Economics, 87, pp. 45-72.

Large, J., 2007, ‘Measuring the Resiliency of an Electronic Limit Order Book’, Journal of Financial Markets, 10, pp 1-25.

Lee, C. M.C. and Mark J. Ready, 1991, ‘Inferring trade direction from intraday data’, Journal of Finance 46, 733-747.

Lesmond, D.,Ogden,J.,Trzcinka,C.,1999. ‘A new estimate of transaction costs.’, Review of Financial Studies, 12, pp. 1113–1141.

Marshall, B. R., Nhut H. Nguyen and Nuttawat Visaltanachoti, 2013, ‘Commodity Liquidity Measurement and Transaction Costs’. The Review of Financial Studies, 25, pp. 599–638.

Næs, R., Johannes A. Skjeltorp and Bernt Arne Ødegaard, 2011, ‘Stock Market Liquidity and the Business Cycle’, Journal of Finance, 66, pp.139-176.

O’Hara, M., 1995, ‘Market Microstructure Theory’, Blackwell Publishers, Cambridge.

Pastor, L. and Robert F. Stambaugh, 2003, ‘Liquidity Risk and Expected Stock Returns,’ Journal of Political Economy, 111, pp. 642–685.

Perold, Andre F., 1988, ‘The implementation shortfall: paper vs. reality’, Journal of Portfolio Management, 14, pp. 4–9.

Schultz, P., 2001, ‘Corporate Bond Trading Costs and Practice: A Peek behind the Curtain’, The Journal of Finance, 56, pp 677-698.

Silber, W., 1991, ‘Discounts on restricted stock: The impact of Liquidity on Stock Prices’, Financial Analyst Journal, pp. 66-64.

Goyenko, R., Avanidhar Subrahmanyam and Andrey Ukhov, 2011, ‘The Terms Structure of Bond Market Liquidity and Its Implications for Expected Returns’, Journal of Financial and Quantitative Analysis, 46, pp. 111-139.

Vayanos, D. and Jiang Wang, 2012, 'Market Liquidity: Theory and Empirical Evidence', Handbook of the Economics of Finance (forthcoming).

Wagner, W., 2011, 'Systemic Liquidation Risk and the Diversity–Diversification Trade-Off.', The Journal of Finance, 66: 1141–1175.

5. Summary of questions

Q1. Given the difficulties with obtaining transactional data outlined here, do you think a data sample cover 2008-2012 is sufficient for this analysis? Would you see merit in extending the sample in those countries where more data is available?

Q2. Do you have additional data sources to suggest? Specifically, can you suggest a source of repo data and gold that would fit our needs?

Q3. Do you agree with the list of liquidity metrics under consideration to be used in the EBA assessment, as mentioned in this section and Annex 5? Can you suggest further metrics the EBA should make use of, where information would be available?

Q4. Do you agree with the list of explanatory characteristics whose linkage to liquidity it is proposed to be tested in the EBA assessment? Can you suggest further characteristics the EBA should assess?

Q5. Do you agree with the methodology proposed? Do you have alternative approaches that might be used?