ICE DATA SERVICES™

LIQUIDITY RISK ASSESSMENT IN BOND MARKETS

INTRODUCING A METHOD FOR MEASURING FIXED INCOME LIQUIDITY

WHITEPAPER

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The topic of bond market liquidity risk continues to attract significant attention among financial institutions, regulators and policy makers. Concern about market participants' ability to effectively manage liquidity risk is being stoked by a combination of factors, including: a multi-year decline in dealer inventories; a sharp increase in the supply of outstanding debt instruments (with no comparable increase in trading volume); proliferation of riskier, less liquid instruments such as leveraged loans; and anticipation that future interest rate increases could trigger a flight from fixed income assets.

In this paper, we:

- Summarise the current market landscape and heightened regulatory focus around more effective liquidity risk management.
- Centre on a definition of "liquidity" as "the ability to exit a position at or near the current value" and examine factors (security characteristics, future price uncertainty and trading volume) that can impact relative liquidity measured against this definition.
- Describe a methodology for measuring the relative liquidity of a security in the fixed income markets.
- Discuss functional uses of a liquidity indicator metric: estimating the potential number of days to liquidate portfolio securities; projecting the potential market price impact of liquidating portfolio securities; and using liquidity indicators to better understand the overall liquidity profile of a portfolio relative to the market.
- Review the compelling results of out-of-sample back-testing, comparing forward-looking estimates of a security's potential liquidity generated by our methodology against future realised market activity.
- Illustrate an approach funds can use to help demonstrate compliance and regulation, including the classification of fund portfolio assets into liquidity profiles.

AN ALTERED AND CHALLENGING LANDSCAPE

The topic of bond market liquidity risk is attracting growing attention among financial institutions, regulators and policy makers. Concern about market participants' ability to effectively manage liquidity risk is being stoked by a combination of factors, including:

- A multi-year decline in dealer inventories as well as higher capital requirements making it more challenging for dealers to enhance liquidity by acting as "marker makers"
- A sharp increase in the aggregate outstanding debt instruments (with no comparable increase in trading volume)
- Proliferation of riskier, less liquid instruments such as leveraged loans

Liquidity risk management is an integral part of the investment process. While liquidity risk affects most categories of market participants, it is especially salient for entities such as open-ended mutual funds, which allow their shareholders to request redemptions at any time. Effective liquidity risk management is therefore most critical during times of market stress, for instance, when redemption activity can lead to selling assets in the open market at sub-optimal prices in order to meet the liquidity demands of shareholders.

REGULATORS ARE ZEROING IN ON LIQUIDITY RISK MANAGEMENT

Global regulators along with policy bodies such as the International Monetary Fund have warned that in a worst-case scenario, a flood of shareholder redemption orders could damage not just particular funds but underlying asset markets and even the financial system itself.[1]

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[1]**Federal Reserve Board Vice Chairman Stanley Fischer**: "…some open-ended mutual funds offer daily withdrawal privileges but invest in assets that take longer to sell and settle, giving investors an incentive to withdraw quickly when distress arises. The fire sales of assets that may result can depress asset prices and increase volatility, with knock-on effects on other institutions and markets. Concerns have grown about this liquidity mismatch as the aggregate value of less liquid assets in such funds has grown."
Speech at Atlanta Fed conference, March 30, 2015.
http://www.federalreserve.gov/newsevents/speech/fischer20150330a.htm
International Monetary Fund: "A large proportion of funds issue easily redeemable shares, and liquidity mismatches have been rising. Open-end funds are exposed to redemption risk because investors have the ability to redeem their shares (usually on a daily basis) while funds have increasingly been investing in relatively illiquid securities such as high-yield corporate bonds and emerging market assets." IMF Report, "The Asset Management Industry and Financial Stability," page 99. **http://www.imf.org/external/pubs/ft/gfsr/2015/01/pdf/c3.pdf**
Bank of England: "Alongside concerns about the resilience of underlying liquidity, global assets under management have grown significantly over the past decade, to around US $70 trillion. Within that, the share of funds typically offering investors short-term redemptions has increased, from just below 40% a decade ago to approaching half…. there remains a risk that significant outflows from riskier asset classes, such as emerging market bonds, could lead to forced asset sales and widespread contagion to other markets." Financial Stability Report, July 2015, page 45.
http://www.bankofengland.co.uk/publications/Documents/fsr/2015/fsrfull1507.pdf

In response, regulatory agencies and policy bodies are adopting or considering a wide range of expanded requirements for firms:

- Increased data reporting requirements
- Strengthened supervision based on a conceptual framework that parallels banking regulations in many respects
- Meet liquid asset minimums and abide by limits on illiquid assets
- Fees and gates to limit redemptions
- Periodic assessment and review of liquidity risk, including stress testing across a spectrum of market conditions
- Establish "transition plans" (a.k.a. living wills) to transition clients' assets away from an advisor that suffers a major disruption in their business

THE FUND INDUSTRY PIVOTS TOWARD IDENTIFYING SOLUTIONS

Prominent fund industry figures also are calling upon the industry to re-examine and revise liquidity risk management best practices to align with the current fixed income liquidity landscape.

A July 2015 white paper issued by BlackRock advised: "Rather than focus on rolling back regulation, we need to adapt to regulatory change and its intended consequences. It's time to shift the dialogue about liquidity to solutions. Asset managers must evolve trading, portfolio construction, and risk management to adapt to market changes."[2] Echoing statements made by some regulators, Bill Gross of Janus Funds recently characterised mutual funds (along with hedge funds and ETFs) as part of the lightly regulated "shadow banking" system – comprised of entities not required to maintain reserves or even emergency levels of cash, and therefore vulnerable to a "run" on the market.[3]

To comply with current and future requirements, fund advisors should adopt and follow appropriate policies to mitigate the danger of being unable to meet redemption demands. Further, fund board members should make sure they understand their fund's liquidity risk management practices and are satisfied that those practices align with industry and regulatory expectations.

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[2]"Addressing Market Liquidity" **http://www.blackrock.com/corporate/en-us/literature/whitepaper/viewpoint-addressing-market-liquidity-july-2015.pdf**
[3]Monthly Investment Outlook, June 30, 2015 **https://www.janus.com/bill-gross-investment-outlook/july4**

LIQUIDITY ASSESSMENT REQUIRES A COMPREHENSIVE APPROACH

Limiting illiquid holdings, however, is only a starting point. Of the multiple elements needed for effective management of liquidity risk, classification of the liquidity of portfolio securities is a critical foundation. Portfolio liquidity risk can be analysed in greater detail and can produce more actionable conclusions if each instrument is assigned a numerical liquidity score rather than merely being classified as either "illiquid" or "liquid."

Furthermore, liquidity risk can affect any asset – not just asset classes traditionally considered less liquid, such as emerging market bonds, non-agency mortgage securities, leveraged loans or even Treasury securities can face liquidity challenges.

Demarcating an "illiquid" bucket within a portfolio provides only partial insight into how liquidity risk could impact the portfolio's net asset value (NAV) under various market conditions. Ranking the liquidity of portfolio securities along a numerical scale can assist in more exact quantification of potential impacts on NAV.

QUANTIFYING LIQUIDITY

We employ the market consensus definition of liquidity as "the ability to exit a position at or near the current value," and focus our attention on measuring liquidity of fixed income securities. Our approach for estimating liquidity at the security level involves quantifying two distinct components of the definition:

1. The ability to exit a position
2. … at or near the current value

Conceptually, the *ability to exit a position* can be considered a product of the characteristics of the security which lend themselves to future "tradability" of the security -- which, in turn, culminates into a view of the security's future potential trading volume capacity. Since the majority of the fixed income universe does not actively trade, historical trading volume data alone may not fully represent a security's future potential ability to trade in the marketplace. Consequently, it is critical to analyse the features and characteristics of the security that impart forward-looking "attractiveness" to prospective buyers.

Quantifying the degree of influence these bond characteristics may exert on future trading behaviors is therefore a vital aspect of projecting trade volume capacity. For example, even if a bond has not traded in the past 6 months, it doesn't mean the bond cannot trade in the future. Essentially, we are solving for this *potential* to trade.

ICE DATA SERVICES LIQUIDITY RISK SURVEY

ICE Data Services has long taken an interest in liquidity risk and in providing data and tools that can help funds more effectively manage it. Our view of funds' needs in this area is informed by both formal research and ongoing conversations with our clients, who include 50 of the top 50 U.S. mutual funds and 49 of the top 50 global asset managers.

In 2014, ICE Data Services conducted an industry survey on liquidity risk measurement. Respondents included 177 senior decision makers, chief investment officers and risk managers from 144 firms, primarily from North America. The survey revealed:

- The majority of respondents defined "liquidity" as the ability to exit a position at or near the current value[4].
- More than 70% planned to use liquidity information to assess their ability to exit positions at the price held in records

The results of the ICE Data Services Survey on Liquidity Risk Measurement (August 2014) can be found here **http://go.interactivedata.com/rs/273-PWD-828/images/Liquidity-Risk-Measurement-Survey-Results-August-2014.pdf**

[4]This definition provides the starting point for formulating a method of quantifying liquidity, described in the next section. Note, too, that the definition directly connects with the SEC definition of an illiquid asset as one whose owner is unable to sell it within seven calendar days "at approximately the value ascribed to it."

ICE Data Services' methodology incorporates multi-factor regression models to perform this function, while relevant factors may include past trading activity, quantity of market quotes, breadth of ownership, and bond characteristics such as issuer, sector, amount outstanding and time since issuance, for instance.

Turning to the latter half of the definition, liquidating a position *at or near the current value*, we naturally associate a security's potential departure from carrying value with its degree of future projected price uncertainty, or volatility. Specifically, all else equal, a security with greater projected price volatility is less likely to be valued at the same price in the future than a security with lower projected price volatility.

In this context, it is important to analyse historical evaluated price movements, the security's risk profile, and current market conditions in order to form a view on future price uncertainty. This notion of price uncertainty becomes even more important as we consider the impact of transacting at a certain position size relative to the projected trade volume capacity, as the anticipated price uncertainty is conditional upon the length of time anticipated to liquidate a position. We will explore this concept further later in the paper.

A PRACTICAL GAUGE OF LIQUIDITY FOR A FIXED INCOME SECURITY

Having projected a security's future potential price volatility and future potential trading volume, the quotient of these quantities represents a liquidity ratio: an estimate of the market price response per dollar traded in that security.[5] The idea is that the lower the liquidity ratio, the lower the anticipated market price impact from transacting in the security (as compared to a security with a higher liquidity ratio), and therefore the greater the relative liquidity of the security. The liquidity ratio has several uses. We begin with a discussion of liquidity scores.

$$\text{Liquidity Ratio} = \frac{\text{Projected future potential price volatility}}{\text{Projected future potential trading volume}}$$

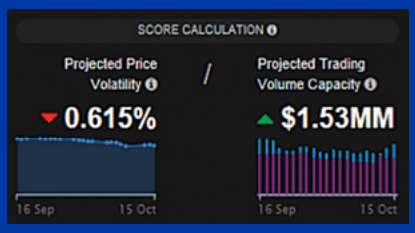
One useful consequence of solving for each security's liquidity ratio is the possibility of directly comparing securities to form a view on how liquid one security is compared with a specified set of securities.

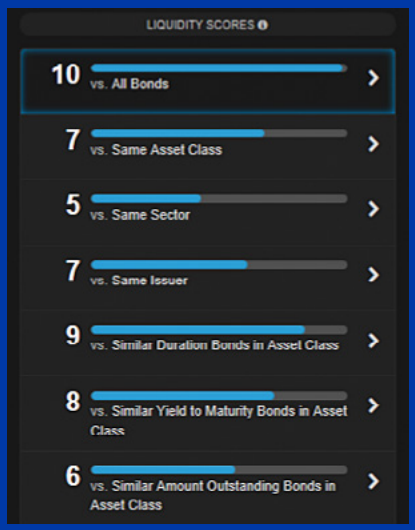
The security ranking process can be performed for any number of groups and sub-groups, with all comparisons expressed along a uniform scale. Liquidity scoring categories can include security vs. universe, security vs. asset class, security vs. sector, security vs. similar duration grouping, etc. In this manner, the relative liquidity of a security can be analysed against a variety of comparable fixed income securities. We order comparison population by percentile ranking, producing a 1-10 ordinal scale (1= lowest and 10 = highest relative liquidity).

[5]While we employ forward-looking estimations as inputs, this ratio is similar in concept to that of the "illiquidity measure" first proposed by Yakov Amihud of NYU Stern Business School (2002); "Illiquidity and Stock Returns: Cross-Section and Time-Series Effects", Journal of Financial Markets 5 (2002) 31–56, **http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.145.9505&rep=rep1&type=pdf**

SAMPLE OUTPUT: RELATIVE LIQUIDITY SCORES FOR A SELECTED SECURITY

The charts below illustrate the application of the process described in this paper to a particular security. First, we calculate forward-looking forecasts of future potential price volatility and future potential trade volume capacity over a specified time period. For the sample security portrayed in the first chart, the projection for price volatility is 0.615%% and the projected trade volume capacity is $1.53 million.





After projecting a security's future price volatility and trade volume capacity, the liquidity ratio - the quotient of these two figures - is then ranked against several security populations to generate a set of liquidity scores for the security. The next chart shows the resulting scores for one corporate bond when ranked against: **1) all securities; 2) securities in the same asset class; 3) securities within the same sector; 4) securities of the same issuer, etc.** This provides a multi-dimensional view of the security's relative liquidity.

Source: ICE Data Services Liquidity Indicators

This uniform scale facilitates the comparison of instruments across asset classes. For example, the liquidity of a European sovereign bond can be compared to a U.S. corporate bond or a FNMA Agency CMO. Furthermore, for expositional ease, portfolio liquidity profiles can be created by aggregating and displaying the distribution of each portfolio constituent's liquidity score on the 1-10 scale; including concentration-weighted and equal-weighted average and median portfolio liquidity scores.

THE IMPACT OF POSITION SIZE

The preceding discussion sets out a generalised approach for estimating liquidity at the security level. Tailoring these metrics to the individual position sizes of securities held within the portfolio is the crucial next step toward forming a view on a portfolio's liquidity profile. Consider an extreme example, with two investors holding the same security: Investor A has a $1 million position and Investor B has a $100 million position.

Suppose the projected trading volume capacity for that security was estimated to be $10 million per day. One might reasonably conclude that Investor A's $1 million position could be liquidated within a day, while Investor B's $100 million position may take longer than a day to liquidate. (Holding all else equal, a linear "days to liquidate" estimate for Investor A would be 1/10th of a day, while the estimate for Investor B would be 10 days).

At the same time, there is a time-dependent cost associated with exiting a position over the course of multiple days, because market conditions may change and influence the price of the asset. We can approximate the effects of this uncertainty by leveraging the volatility estimates used in calculating the liquidity ratio.[6]

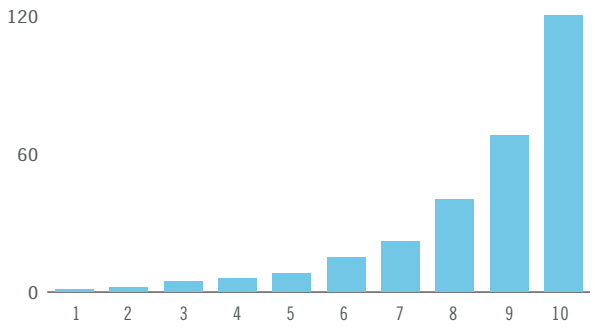
BACK-TESTING SIMULATION: PROJECTIONS VS. REALITY

ICE Liquidity Indicators are designed to function as forward-looking estimates of a security's potential liquidity. As typical with model-driven estimates, it is important to perform back-testing analysis to examine the effectiveness of these forecasts. One intuitive test is to group portfolio securities by their liquidity score categories as of a certain historical point in time, and track the following month's realised trading activity. The following analysis was performed on a sample of more than 25,000 U.S. corporate bonds, grouped into deciles based on liquidity score. Results are summarized in the chart below, using liquidity scores calculated as of July 31, 2015 **compared to trade counts and trade volumes** realised for the month of August 2015.

[6]This estimation of price impact can be augmented further with a measure of bid-ask spread as part of a liquidation cost estimation process.

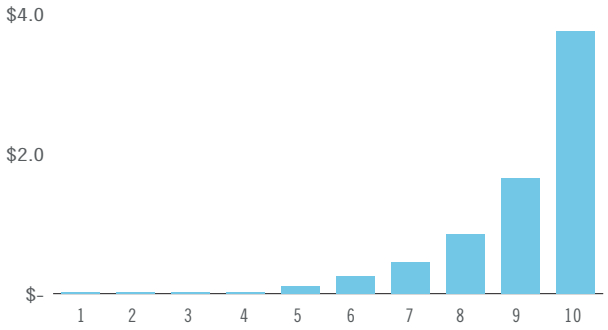
The following charts show that higher liquidity score rankings were associated with higher ex-post trade counts in a monotonic relationship. Because more liquid securities are generally expected to experience higher levels of trading activity in the future, this back-testing result is intuitive and supports the premise of our methodology.

Realised Future Daily Average # Trades Per Security (Aug - 2015)



Liquidity Score Categories (calculated as of Jul 31, 2015)

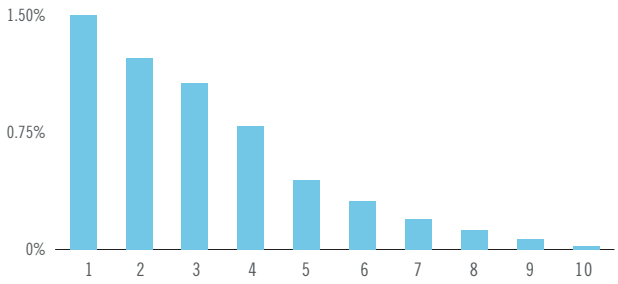
Realised Future Daily Average Trade Volume ($MM) Per Security (Aug - 2015)



Liquidity Score Categories (calculated as of Jul 31, 2015)

Another approach to back-testing involves comparing the relationship between liquidity scores and future realised price changes per dollar volume traded. To back-test the validity of our liquidity scores applying this test, we first grouped investment grade corporate bonds by liquidity score for each trading day in July, 2015. We then analysed price movements observed in the universe of bonds throughout the course of the month. We calculated one-day "price movement" as the change from our end-of-day evaluated price the day prior to the observed trade to the volume-weighted average price (VWAP) of the bond on the day of the observed trade. Next, we calculated the absolute value of this "price movement" and divided by the total dollar volume traded that day to estimate the "price impact" per dollar traded of the bond. Finally, we calculated the average "price impact" for all bonds on each trading day grouped by liquidity score over the course of the month. The results are presented in the accompanying chart. The chart illustrates the average "price impact" (per $10,000 trade volume per bond) grouped by liquidity score.

Realised Future Price Impact per $10,000 Trade Volume Avg. Per Security Per Trade (July – 2015)



Liquidity Score Categories
(calculated the day before trade observations in July 2015)

From this out-of-sample back-test, a clear pattern emerges. The lower the liquidity score, the higher the future observed price impact per dollar volume traded. Conversely, the higher the liquidity score, the smaller the future observed price impact per dollar volume traded. That is, the greater the "liquidity" (as measured by our liquidity scores), the lower the price impact observed in future transactions.

CLASSIFYING PORTFOLIO HOLDINGS BY DAYS TO LIQUIDATE

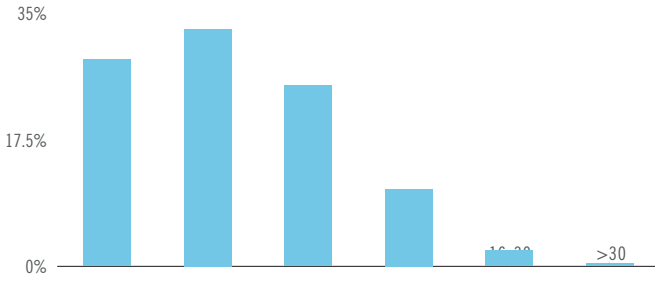
The approach we have described in this paper projects potential trade volume capacity at the security level, providing a basis to aggregate and form a view on portfolio

liquidity based on position sizes. The portion of a portfolio that can be liquidated within pre-defined time periods can then be calculated by comparing the par amount of each holding with the projected trade volume capacity for that bond.

The allocation of a portfolio into different buckets based on days to liquidate can assist with meeting requirements from various regulations and guidelines to project the time horizon of liquidating a portfolio.

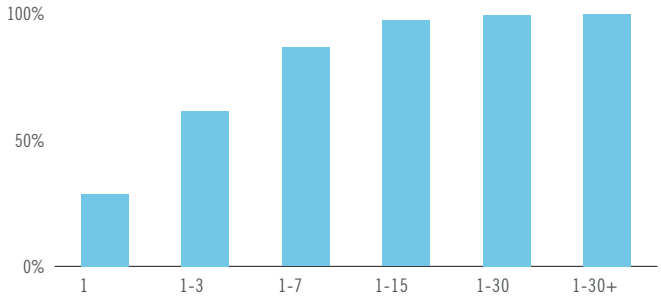
The charts below summarise a simulated analysis for an actual U.S. corporate bond portfolio comprising more than $20 billion par value. First, we project the liquidity profile of the portfolio and organise into the liquidity buckets. Next, we aggregate the cumulative portion of the portfolio projected to be liquidated over time. The analysis projects that 86.7% of this portfolio's assets can be liquidated within 7 days.

Percentage of Portfolio Liquidation Projected per Liquidity Bucket



Projected Days to Liquidate Percentage of Portfolio by Discrete Buckets

Cumulative Percentage of Portfolio Liquidation Projected per Liquidity Bucket



Projected Days to Liquidate Percentage of Portfolio by Cumulative Buckets

CONCLUSION

As regulators and policy makers increasingly concentrate their attention on bond market liquidity as a potential source of systemic risk, the financial industry is re-examining and revising liquidity risk management practices to better align with the shifting fixed income landscape. ICE Data Services has been heavily engaged in the industry dialogue, surveying the marketplace to understand requirements and conducting extensive research to develop an approach for measuring liquidity of fixed income securities. The definition of liquidity we end up solving for is "the ability to exit a position at or near the current value." Given this definition, a possible approach for estimating liquidity at the security level involves quantifying a security's future potential trading volume capacity (which is associated with "ability to exit a position") and the degree of future price uncertainty, or volatility (which will influence the potential price discount from current value when exiting a position). From here, we calculate a liquidity ratio, or an estimate of the potential market price response per dollar traded in that security, which is then used to rank order securities and generate liquidity scores. Next, we administered a back-testing approach to examine the out-of-sample effectiveness of these model forecasts by comparing spot projections to future realised trading activity.

Finally, we analyse a US corporate bond portfolio, and demonstrate how the Liquidity Indicators content can be utilised to analyse the relative liquidity of portfolio securities as part of a liquidity risk management program.

ABOUT ICE LIQUIDITY INDICATORS

ICE Liquidity Indicators provides an independent view of near-term relative liquidity – informing your decisions with a better understanding of security and portfolio liquidity. Our uniform liquidity scale facilitates the comparison of securities across asset classes.

ICE Liquidity Indicators content can be applied to use cases such as:

- **Days to liquidate:** Calculate projected days to liquidate a portfolio of securities
- **Portfolio liquidity profiles:** Determine portfolio liquidity profiles and analyse trends over time versus comparable benchmarks
- **Market impact:** Project potential market price impact for a trade of a certain size
- **Stress testing:** Calculate projected days to liquidate portfolio securities and potential market price impact under normal and stressed market conditions
- **Risk management and compliance:** Measure portfolio liquidity trends and demonstrate compliance to regulators
- **Board reporting:** Report on portfolio liquidity profiles, including trends over time to demonstrate regulatory compliance
- **Investment selection:** Use relative liquidity analytics as an input in the investment decision-making process
- **Collateral management:** Support eligibility determinations and monitor the liquidity of collateral holdings
- **Creating indexes and investable products:** Use ICE Liquidity Indicators as part of the selection criterion in the design of an index or investable product

FURTHER INFORMATION

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