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Managing the liquidity mismatch for mutual funds

The mismatch between mutual funds and the underlying liquidity environment in the secondary market for corporate bonds in Europe and the United States

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Managing the liquidity mismatch for mutual funds in the secondary corporate bond market

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Management summary

In the asset management business, the number one work ethic is to always put the client's best interest first. As investors of the pensions, insurances and savings of the people, asset managers have observed numerous changes in the financial landscape since the crisis of 2008. To protect the investments of their clients, asset managers pursue innovative proposals to act on the deteriorated liquidity in the corporate bond market.

A lack of liquidity in the corporate bond market followed from the increased regulatory scrutiny for the capital risk takers, the market-makers. Regulation charges balance sheets and forbids proprietary trading, reducing the risk taken by these market makers. In earlier times, the capital risk absorbed market shocks as it would be profitable for a market maker to trade for his own book. As this is no longer the case, the immediacy, depth and resilience in the corporate bond market suffer.

Investment managers offer open-ended mutual funds to their clients that promise daily liquidity. To service daily inflows and outflows, portfolio managers use the more liquid assets of the portfolio to remove the pressure to sell the underlying assets with each redemption. The mutual fund manager focuses on his fiduciary duty towards both their parting and remaining end-clients. The liquidity mismatch shows that a parting end-client obtains the liquid part of the portfolio when they redeem their shares in the fund. Possible redemptions of the remaining clients run the risk that the fund manager has to sell bonds on a discount, reducing the value of their shares of the fund. Effectively, the remaining end-clients pay for the liquidity option of the parting end-client.

The thesis starts with an overview of the liquidity environment for both the American and European market. We analyze American trading data provided by TRACE with liquidity proxies. We present analysis of the market practices to forecast liquidity and transaction costs. We apply the market practices to three model portfolios, covering the Investment Grade and High Yield spectrum of the corporate bond market.

We use the liquidity analysis as a guiding principle for the interviews with an array of financial professionals. We apply a semi-structured interview approach and conduct a consultation with 20 participants during 18 sessions. The main topic of these discussions was the current liquidity environment in the European corporate bond market and the possibility from the regulatory, market and individual fund manager levels to mitigate the liquidity mismatch. We classify the subjects we discuss during interviews on their usefulness and provide a consolidated overview with the assigned value to each proposition.

We find that portfolio managers already work with a heightened level of cash and liquid assets in their portfolios, and are in close contact with their larger end-clients. We advise fund managers to use a swing price to protect their end-clients and adjust the swing price according to the market conditions. A time-model or transactions in kind can be used to reduce the transaction costs for both the mutual fund manager and the investor.

Preface

With this graduation thesis, the final work of my 7.5 year journey as a student concludes. A significant period for any person and this also holds for me. The freedom to develop yourself with both study related activities and the possibility to explore yourself with extracurricular activities. My journey took me from Enschede, Costa Rica and Mexico, Germany and Sweden to The Hague.

For the past six months, I have been a part of the Investment Services team at NN Investment Partners. I would like to express my gratitude for the warm welcome I received from the Investment Services team and the possibility to conduct my research. Another word of thanks goes out the team of European High Yield, who showed me the practicality behind the world of investing.

I would like to direct a special word of thanks to my supervisors, Sylvia van de Kamp-Vergeer from NN Investment Partners and Dr. B. Roorda and Dr. R. Joosten from the University of Twente. They provided valuable feedback throughout my research.

Last, but certainly not least, I want to thank all people close to me for their support and their welcome distractions.

Acronyms

AuM	Assets under Management
AIFMD	Alternative Investment Fund Managers Directive
AR	Auto Regression
BVAL	Bloomberg Valuation
CDS	Credit Default Swap
COFIA	Class of Financial Instruments Approach
DxS	Duration times Spread
ESMA	European Security and Markets Authority
ETF	Exchange Traded Fund
HY	High Yield / Junk / Speculative
IBIA	Instrument By Instrument Approach
ICMA	International Capital Markets Association
IG	Investment Grade / High Grade
IMF	International Monetary Fund
ISIN	International Securities Identification Number
KIID	Key Investor Information Document
LCS	Liquidity Cost Score
MF	Mutual Fund
NAV	Net Asset Value
OAS	Option Adjusted Spread
OASD	Option Adjusted Spread Duration
OTC	Over-the-counter
SEC	Securities and Exchange Commission
UCITS	Undertakings for Collective Investment in Transferable Securities

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1. Overview of the corporate bond market

The financial crisis of 2008 set in motion drastic changes to the global financial markets. The increased scrutiny from new regulation, the media and society make financial institutions wary of any negative attention. However, a new liquidity crisis looms in the asset management business as a result of these reformed financial markets. Asset managers are promising their clients daily redemption opportunities from their mutual funds. In practice, the percentage of a portfolio that an asset manager can liquidate without an impact on the trading price is much smaller.

Portfolio managers currently strive to service fund outflows with the liquid part of their portfolios to prevent unnecessary trading costs. If a large portion of the fund is redeemed, the sale of illiquid assets might be necessary. This possibly pushes the price of the illiquid assets downward fast and might force the asset manager to discount the value of the mutual fund. This creates a first-mover advantage for redeeming investors, as portfolio managers service the first redemption with the liquid part of the portfolio. The remaining investors in a mutual fund are thus left with a more illiquid portfolio that carries more risk to take a discount on the value of the underlying assets.

This first chapter presents the background on the thesis' subject, the critical concepts and the outline for the rest of the paper.

1.1 Nature of the American and European corporate bond market

Over the past few years, the corporate bond market worldwide has grown significantly. The US corporate bond market went from $5.2 trillion to $7.2 trillion[1] and the European Securities and Markets Authority (ESMA) reported that Assets under Management (AuM) for all funds almost doubled since 2007. The financial crisis of 2008 and the subsequent legislation, such as Basel III, the Volcker-rule and the Dodd-Frank Act, reduced the appetite for risk in banks. While traditionally a bank supplied a loan to a firm, these companies turn more and more to the corporate bond market for different reasons (ICMA, 2013). The lower interest rate policy of central banks further fuels the outstanding debt in the corporate bond market, due to the low costs to finance the debt.

A corporate bond is a debt security issued by a corporation. Investment banks help the corporations to issue the corporate bond in the primary bond market. A corporate bond consists of several characteristics for the benefit of the issuing corporation. The corporation can choose the issue size and the maturity date, which is the date in the future on which the principal amount will be repaid. The corporation can also choose an interval to pay the coupon, of which the standard is a semiannual coupon payment. Furthermore, it is possible to incorporate early redemption options or floating-rates. An early redemption option gives the issuing corporation the possibility to pay back the principal amount on a 'call' date, terminating the bond and the future interest payments. Floating-rate bonds are bonds with adjustable interest rates which depend on market rates through an index. After taking into account all the issuer preferences for the bond and the credit risk of the company, the accompanying

[1] SIFMA: http://www.sifma.org/research/statistics.aspx

investment banks determine an appropriate interest rate to compensate investors for their risks. These investors will then buy the bond in the primary market.

Trades that happen after the issuance of a bond occur in the secondary market. The initial investors in the primary market or other investors might want to buy or sell the bond due to their risk/return profile. Various types of investors exist, such as hedge funds, asset managers, sovereign wealth funds, insurance companies or pension funds. These financial institutions have varying time horizons and long term liabilities to their clients. These institutions serve as the buy side of the market. The sell side comprises of firms that service these institutional investors. Examples of sell-side firms are investment banks, market makers and rating agencies. The investment banks deal with the primary issuance and research. The market makers provide liquidity in the securities that they trade. The rating agencies determine the credit worthiness of an issuer with respect to a specific issue. The highest rating in the spectrum is AAA, for the perceived safest debt obligations. The rating C is the lowest rating, after which D represents a default of the security. Investment grade (IG) is everything above BBB- and is considered a safer investment than High Yield (HY). High Yield is everything from BB+ to C. The ratings may change with the outlook on the probability of default of the company or country.

The trades in the secondary market occur in an over-the-counter (OTC) manner. Over-the-counter refers to a dealer network, as opposed to a transparent exchange which is normal for equities. Corporate bonds in the secondary market can therefore only be bought through market-makers or broker-dealers, which increases the opaqueness of the market. The possibility that a single issuer has several bonds outstanding further complicates the search for a counterparty in a trade.

1.2 Market liquidity

Liquidity in the financial world can be split up into two categories. Funding liquidity and market liquidity (Hull, 2012). Funding liquidity is the ability to settle obligations with immediacy (Drehman & Nikolaou, 2010). Market liquidity indicates the ability to sell an asset without severely affecting the price (Moffatt, 2015). Market liquidity is what we have in mind when we refer to liquidity in the rest of this thesis.

Market makers in the corporate bond market facilitate the buying and selling of financial securities in the secondary market. The speed, price and volume with which the trade can be executed in the secondary markets are a representation of the ability to liquidate an asset in the market.

If an asset is able to trade at a moment's notice, close to the previous price and in large volume, that market can be identified as a liquid market. If an asset takes a while to trade, with larger price differences for every trade that executes and an increase in bid-ask spread when we add more volume, we can identify an illiquid market. When talking about market liquidity, the key criterion is not *"Can you sell it?"* but *"Can you sell it at a price equal or close to the last price?"* (Marks, 2015).

1.3 Investors, investment vehicles and the liquidity mismatch

Institutional investors are in the business of pooling money to manage the risks and returns in a predetermined market or asset class. Portfolio managers use strategies to obtain a risk level on their portfolios that they are comfortable with in order to achieve outperformance versus a benchmark. The

benchmark is usually an index that every portfolio manager uses to show their relative performance towards the market they are operating in. To be able to invest money from end-investors, institutional investors set up investment vehicles. Depending on the characteristics of these vehicles, they are suited for other institutional (end-)investors, retail investors, or both.

The commonly used investment vehicle in Europe is the "Undertakings for Collective Investment in Transferable Securities" (UCITS) fund. The other possibility in Europe is the "Alternative Investment Fund Managers Directive" (AIFMD) fund. Currently, around 67,000 UCITS are registered in Europe (PwC, 2014) with approximately €6.9 trillion in assets. The dominant investment vehicle in the United States is the "Mutual Fund" structure. The most common type of mutual fund is the open-end fund, allowing investors to move in and out on the fund on a daily basis versus the Net Asset Value (NAV) of that day. The European based UCITS structure allows a wider variety of investment and redemption periods, varying from daily moves similar to US based mutual funds to a minimum of twice a month. Both types of funds may charge entry and exit fees to compensate existing shareholders for the transaction costs of redemptions and investments. The market term for these exit and entry fees is the "swing factor". Additionally, the regulation of the investment vehicles also provides protocols which can be used in times of market stress.

Given their flexibility, UCITS are in demand by end-investors. In order to meet client expectations, European UCITS fund managers follow their American mutual fund colleagues in offering daily in- and outflow from their investment vehicles. A mismatch develops when the underlying securities in the investment vehicle are more illiquid than the liquidity option of an end-client. This is the liquidity mismatch.

The liquidity mismatch varies with asset classes and types of funds as their underlying liquidity and redemption periods differ, as shown in Figure 1.1.

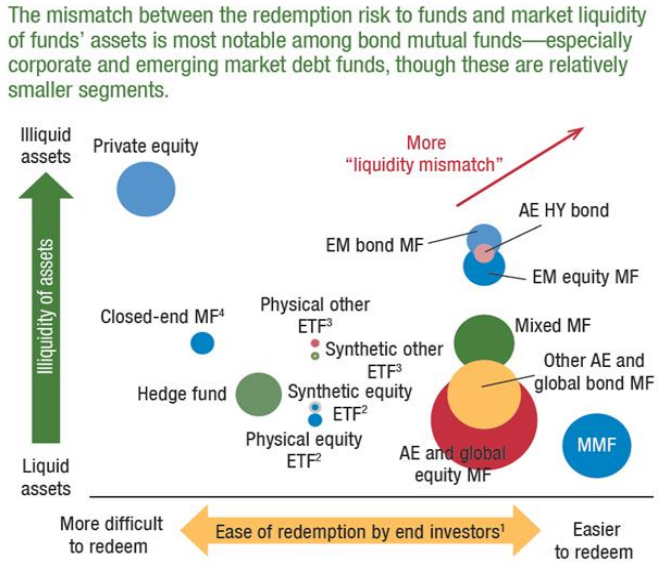

Figure 1.1: Liquidity Mismatch - Size of bubbles is global assets under management (end-2013, all investment vehicles) (Source: International Monetary Fund (IMF, 2015))

1.4 Research outline

In this research, we give an overview of the current liquidity measures and perspectives from the market, for both the European and American corporate bond market. We extend the traditional Value at Risk (VaR) analysis with a liquidity score and give a fund level indication of the liquidity and liquidation risks. We consult with market participants on the changing environment of the corporate bond liquidity and their view on the courses of action for the regulators, the market as a whole and for individual financial institutions. Suggestions to manage the mismatch follow the interviews and liquidity analysis. These suggestions provide guidance and give insight to asset managers to motivate policy in light of their fiduciary duties.

The goal of this research is to:

> *"Give insight to asset managers and financial market regulators on the liquidity mismatch in the secondary market of corporate bonds."*

The main research question follows from the combination of the research goal and the described liquidity environment. The sub-questions divide the main research question in manageable parts and at the same time provide a structure to the thesis.

The main research question is as follows:

> *"How should mutual fund managers and regulators deal with the mismatch between the liquidity offered by UCITS and the underlying liquidity environment, in the secondary market of European and American corporate bonds?"*

To answer this main research question, it is divided in the following sub-questions:

1. *What is liquidity in the corporate bond market, defined by academics, regulators and market participants?*
2. *How to incorporate liquidity risk in risk management models for non-bank financial institutions?*
3. *What measures could portfolio managers take to fulfill their fiduciary duty towards their end investors and treat them in the same manner?*
4. *What guidelines can be used for a swing pricing model for fund level redemptions?*

The sub-questions build on the knowledge acquired in the previous sections. The first sub-question provides a definition on liquidity and a market overview. The second sub-question looks at the risk management perspective and gives a framework to assess it on a fund level. The third sub-question combines the theoretical ideas with practical views from market participants. In the fourth sub-question, we suggest theoretical and practical measures to deal with the presented mismatch.

This research is organized as follows: we discuss the context of the research in Chapter 2; Chapter 3 provides our theoretical framework on liquidity. In Chapter 5 we state the liquidity risks. In Chapter 6 we propose a classification model for the consultation of market participants and we realize the model. In Chapter 7 we offer suggestions to manage the perceived mismatch. In Chapter 8 we conclude the research and present suggestions for further research.

2. Research Context

In this chapter we expand on the problem context as described in Chapter 1. First, we discuss the background of the main research question. Furthermore, we present the theories underlying bond valuation in Section 2.2. In Section 2.3 we introduce the datasets that have been used in this study.

2.1 Problem context

The liquidity mismatch we present in Chapter 1 consists of two parts. The first part is the liquidity option for an end-investor. The second part is the liquidity environment of the underlying securities in which the portfolio manager invests. In this problem context, we first elaborate on the potential causes for the current liquidity environment in the American and European corporate bond market. An explanation of the liquidity mismatch follows the presented liquidity environment. A flowchart with the suggested correlation and causation effects from this problem context can be found in Appendix A.

2.1.1 Liquidity environment

First and foremost, the role of dealers inside the larger banks changed due to a combination of the Volcker Rule, the Dodd-Frank Act and Basel III. Before the crisis the broker-dealer of an investment bank would run a liquidity game, in which the broker-dealer bought both the corporate bond and a Credit Default Swap (CDS)[2] for a corporation to earn several "risk–free" basispoints (bps). As a result of the balance sheet and leverage legislation, this liquidity deal is not profitable any more. Additionally, legislation added a ban on proprietary trading for these broker-dealers of investment banks. Currently, the compensation for the broker-dealers is not sufficient to mitigate the costs for keeping assets on their balance sheet. Due to the increased costs, broker-dealers attempt to line up the buyer and the seller of a corporate bond without risking any capital themselves, which we show in Figure 2.1.

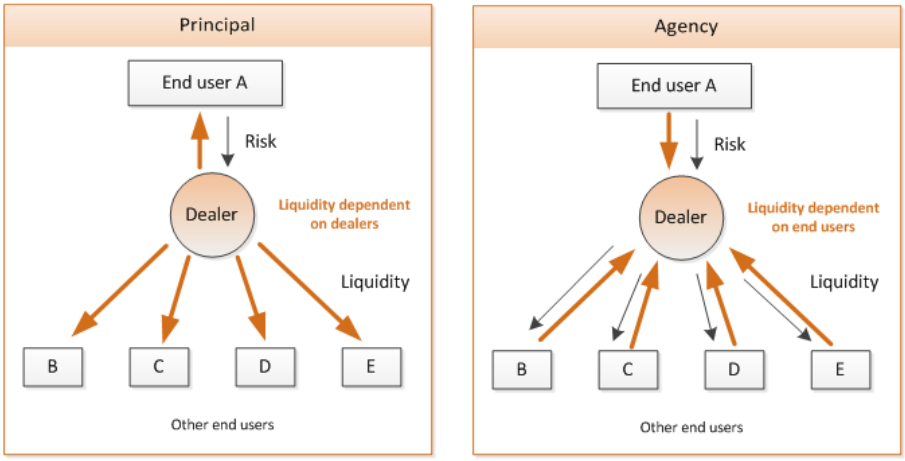

Figure 2.1: Principal to Agency risk (Source: Citi Research)

The change in risk taking by broker-dealers is one of the perceived causes for the decline in daily turnover ratios and the net amounts of dealer inventory. Figure 2.2 shows the decline in average trading

[2] A Credit Default Swap insures the buyer in fixed income products against credit events of a debt issuer. This requires a premium. In case of a default or credit event, the seller pays the premium plus all interest payments that would have been paid until the maturity of that security.

volumes over the past ten years. The trading volume displayed in Figure 2.2 uses the total trade size on a day and divides by the outstanding total bond volume in the Investment Grade and High Yield rating. Figure 2.3 shows the aggregate dealer inventories over the past years. A high dealer inventory enables immediate trades between the dealer and their client, as the dealer can provide the bond directly from his inventory. A low dealer inventory increases the possibility that a dealer cannot provide the asset for the trade immediately, after which other end-users have to be contacted to fill the demand. The reduction of dealer-inventories visible in Figure 2.3 indicates a rising dependency on other buy-side investors when trading bonds. The buy-side is thus providing the liquidity towards other buy-side firms, increasing the price movement shocks in credit events. These shocks occur as the buy-side primarily focuses on performance, whereas dealers focus on trading volumes. The buy-side firms therefore need higher return incentives to take on extra risk in volatile times, contrary to the trading flows desired by dealers.

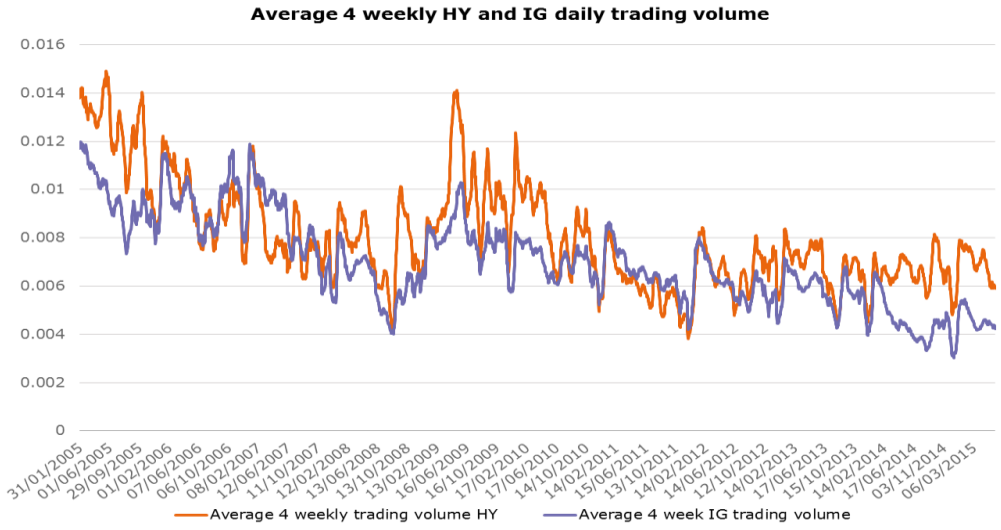

Figure 2.2: Rolling average trading volumes for HY and IG in % against amount outstanding (Source: Deutsche Bank)

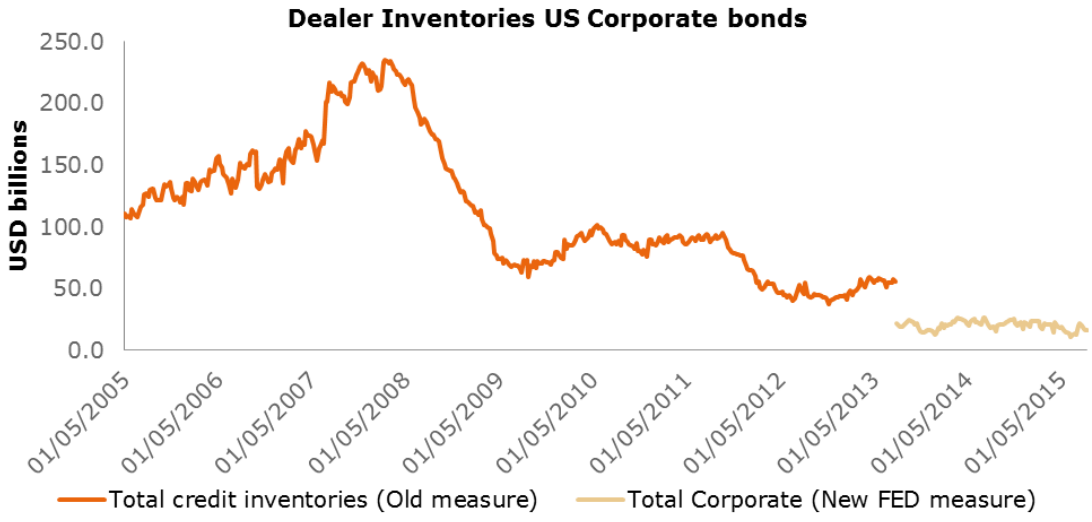

Figure 2.3: Dealer inventories US (Source: FED Primary dealer statistics)

Sell-side banks earn less on corporate bonds, due to the limitation of the liquidity game and proprietary trading. This results in the reduction of the profitability for the sell-side banks, which over time lowers their analyst and research capacity (UBS, 2015). Fewer analysts on the same number of issuers implies less knowledge on these names, all else being equal. The impact of fewer analysts extends if the variety of corporate bond issuers increases, which has been the case in the American and European corporate bond markets. This lack of knowledge contributes to the uncertainty about specific bonds, resulting in higher spreads to compensate for the risk factor in the corporate bond.

The nature of the credit markets further reduces the perceived liquidity. Typically, a corporation only has one share in an index versus a possible 10 to 50 different bonds outstanding in varying currencies. These bonds vary also in maturity, coupon and issue size. If the total volume of outstanding bond and equity is equal, an average bond has a smaller size than the outstanding equity of the same company. The supply of a specific bond is therefore scarce when we compare it to the equity of a specific company. Investor demand for a bond also spreads, as the bond characteristics matter to an investor. This results in less overall trades for the bonds of a company when comparing it to their stocks. Additionally, investors execute credit trades in an over-the-counter manner, contrary to the more transparent exchange traded equity. The dealers in these over-the-counter networks only state supposed pre-trade prices, while not reporting on completed trades. Subsequently, the bid and ask volumes and the bid and ask prices are not certain.

The increase in herding behavior (Roubini, 2015) from buy-side investors further reduces liquidity in the market. When one buy-side firm decides for whatever reason that it wants to unwind a position, it is often the case that many other buy-side firms with similar position decide they want to do the same thing. The liquidity normally present in the market then evaporates. This phenomenon is the “liquidity black hole” (Hull, 2012).

2.1.2 Liquidity mismatch

The liquidity mismatch works as follows: the UCITS framework obliges asset managers to give investors an exit twice a month (excluding special conditions). Asset managers are actually offering daily redemptions to meet end-investor expectations and market standards. The underlying bonds in which a portfolio manager invests could be more illiquid than expected, to the extent that trading the securities results in a discount on the value of the securities. When a portfolio manager has to sell a large portion of the underlying bonds to service the daily redemptions of end-clients, this might result in a significant decrease in the valuation of the total fund.

The investment strategies of portfolio managers focus on the longer term. In the case of outflows, portfolio managers will preferably use the more liquid part of their portfolio to service these outflows. The liquid part in a portfolio allows the portfolio manager to not influence the NAV of the portfolio by preventing unnecessary trading costs. However, portfolio managers can only provide a limited level of cash before they need to sell liquid and less liquid bonds. Liquidating illiquid positions can heavily its price, especially if the bond trades infrequently or the market moves down.

The result of these outflows is that the first end-investor receives the NAV of the portfolio as intended by the portfolio manager. The next end investor that redeems his money might already trigger the sale of more illiquid bonds. This creates the liquidity mismatch between the valuation of the portfolio by the traded quotes in the market and the true liquidity of the bonds, which can be seen when an investor tries to sell certain volumes in a relative short time frame. Figure 2.4 shows the consequences of these subsequent redemptions for a portfolio with an initial strategic allocation of 90% illiquid bonds, 8% illiquid bonds and 2% cash. After the two redemption of in total 10% of the fund over a short period, the remaining investors hold only shares in an illiquid portfolio. If a remaining investor then uses his right to redeem his shares, illiquid bonds need to be sold and the fund will discount the value of the shares for redeeming and remaining investors.

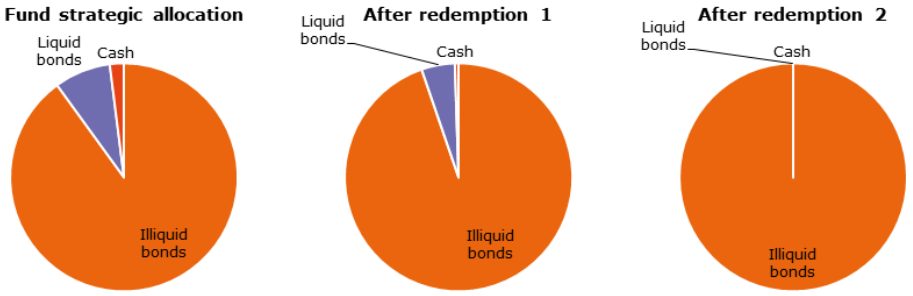

Figure 2.4: Redemption effect on the portfolio

The larger the inflow of money, the more the market risk of the fund dilutes. Figure 2.5 shows this dilution effect for a portfolio that absorbs an investment with an initial composition of 90% illiquid bonds, 8% liquid bonds and 2% cash. The added cash then dilutes the percentage of bonds in the portfolio, reducing the risk/return profile. Portfolio managers need to reinvest the added money in bonds to regain the intended risk/return profile. The portfolio offers its shares against a bid valuation, so new cash crosses the bid-ask spread to buy new bonds for the risk/return profile. Current investors also need compensation for this effect.

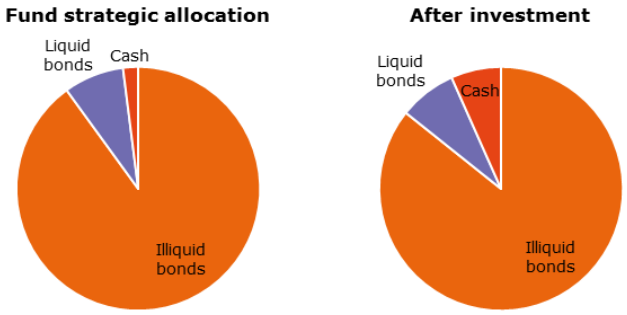

Figure 2.5: Dilution effect on the portfolio

As a first line of defense asset managers implement swing pricing, a charge on exits and entries in the fund to protect the current investors.[3] When an end investor wants to move his money, the swing factor

[3]ALFI http://www.alfi.lu/sites/alfi.lu/files/ALFI_Swing_Pricing.pdf

calculates a certain fee for the transaction costs and market impact that is the result of the inflow or outflow of money. This swing factor is therefore a penalty to the moving end-investor to remedy the effects for the remaining end-investors in a fund.

2.2 Corporate bond valuation

2.2.1 Bond valuation

Conceptually, a bond is an exchange of money at the present time towards an obligation to pay that money back with interest at a predetermined expiration date. Corporations and (local) governments predominantly issue bonds, which supplies them with the necessary cash to fund infrastructure projects or to buy a competitor. The issuer of a bond obliges himself to compensate his investors for the act of lending out their money. The level of compensation depends on the perceived risk of lending to the specific corporation or government.

The first factor that determines the compensation for lending money to another entity is the risk-free rate. The risk-free rate is the minimum return an investor expects for running zero risk. This originates from the time value of money and the devaluation of the money that occurs due to inflation. Traditionally, the market considers U.S. Treasuries or German Bunds to be risk-free. Changes in these risk-free rates correspond to changes in the expected return when an investor does run risk as the additional risks are a premium on top of the risk-free rate.

The second factor to take into account when evaluating the required return on a bond is the default risk. A corporate bond is perceived to have some probability of default in the coming years, creating the possibility of not fulfilling their debt obligation at the coupon payments or at maturity. The compensation for this default risk is part of the risk premium on top of the risk-free rate.

The risk premium on the risk-free rate also factors in several other risks. Contributing factors are reinvestment risks on callable bonds and the coupon payments, inflation risks on bonds with a fixed rate coupon, and liquidity risks. A reinvestment risk occurs when the issuer pays back the bond before maturity, leaving the investor with a higher cash level and possibly lower earning rates than expected. Inflation reduces the purchasing power of money, requiring a compensation for the loss in value of the money. Liquidity risk is the risk that it is impossible to trade a bond close to the last traded price.

2.2.2 Market Theory

The classical Efficient Market Hypothesis (EMH) by Fama (1969) assumes that asset prices ‘fully reflect’ all available information. All participants in financial markets have all the available information, act rationally and have no transaction costs. In the semi-strong markets model, all participants have access to all publicly available information and in the weak-form the theory tests the historical prices or return sequences. Random events are acceptable in efficient markets, as the prices will revert to the norm. The reversion to the norm happens over time, although there is no clear definition on the speed with which this occurs. As a result, the volatility in the current price could deviate heavily under the weak-form hypothesis.

Bond prices have a value based on the net present value of the future cash flows. The bond characteristics, such as the coupon, maturity, callability and perceived risks are available in the market. This constructs the fundamental bond price, against which a rational market should trade the bond. In the over-the-counter environment of High Yield, only a limited number of institutional investors and market makers participate in the market. Communication with the board of a corporation and the availability of analysts at an investment company, together with the increase in issue size and issuers over the past years, increases the likelihood of discrepancies in information between market participants. The information discrepancy is partially able to persevere since the over-the-counter market lacks a central clearing system, which would provide a more centralized information stream. As the nature of the over-the-counter fixed income market is diverse and only a few market makers are active, the assumptions from the Efficient Market Hypothesis are difficult to apply.

The weak form version of Efficient Market Hypothesis is the most likely version to hold in the corporate bond market, as fundamental research can provide extra returns. As the financial markets consist of human investors, human behavior influences the decision making. Portfolio managers in the corporate bond market search for appropriate risk versus return payments, where the upside is the normal bond payment and the downside is a loss of the principal. Especially in the High Yield environment in which the number of total market participants is small, human behavior might interfere with the fundamentally correct price.

2.3 Data

We use the Enhanced TRACE data for the analysis of the academic liquidity proxies over the period from July 2007 until December 2012. The Trade Reporting and Compliance Engine (TRACE) is the mandatory reporting system for the over-the-counter secondary corporate bond market in the U.S. Fifteen minutes after a trade completes it shows in the TRACE database. We omit trades smaller than 100.000, the threshold for institutional trades. We also omit cancellations or other special issues from the TRACE data set.

We supplement the TRACE dataset with Bloomberg data on issue amounts. Bloomberg also provides the data for the Bloomberg Valuation (BVAL) scores.

Barclays offers a portfolio construction tool, POINT. This database gives information on the Liquidity Cost Score (LCS) of different securities. POINT LCS values are available since June 2009 for U.S. corporate bonds and from January 2010 for the European corporate bond market.

We extract the Transaction Cost analysis data and model from Green Package. Green Package is the risk management tool of Aladdin, an operating system for portfolio management offered by BlackRock.

For the qualitative part, we conduct a total of eighteen interviews, across 15 different companies. The participants varied from portfolio managers of corporate bond strategies, market-makers, analysts, academic researchers and risk managers. The combined portfolio managers overlook around €34 billion in assets. We transcribe the interviews to make them eligible for our analysis and classification.

3. The liquidity environment

In this chapter we present a description of the outlook from scientific literature on liquidity, proposals by the regulators to classify liquidity and market practices to quantify liquidity. It starts with a definition on liquidity and the implications of that definition. A description of the liquidity measures from the literature follow. Subsequently we summarize the proposals to assess liquidity from the regulators and representative bodies of the financial markets. Then, we give an overview of the liquidity measures employed by market participants. A further explanation of the methodologies of the LCS value from Barclays, the BVAL from Bloomberg, the Transaction Cost model in Aladdin and the Liquidity Score by Issue from Citi follows. At the end of each section we add a perspective to provide context on the section. The chapter wraps up by an overview of the preferred liquidity measurements from stakeholders, based on the perspectives at the end of each section.

3.1 Definition

To be able to define liquidity, we use insights from both market research and literature. Hill (2014) starts to describe liquidity as a "state", rather than a metric. One of the interviewees (Hill, 2014) stated liquidity to be: *"The ability to get a price in any instrument, in reasonable size, at any time."* In a market update by Howard Marks, he defines the liquidity criterion to be: *"Can you sell it at a price equal or close to the last price?"* (Marks, 2015). Bushman et al. (2010) note that liquidity is: *"The ease with which a security can be traded.*" From the lexicon of Financial Times, the definition on liquidity is the following: *"How easy is it to perform a transaction in a particular security or instrument. A liquid security is easy to price and can be bought or sold without significant price impact. Trying to buy or sell an illiquid instrument may change the price, even if it is possible to transact.*" (Financial Times, 2015). Investopedia describes liquidity as: "*The degree to which an asset or security can be bought or sold in the market without affecting the asset's price. Liquidity is characterized by a high level of trading activity."* (Investopedia, 2015).

The liquidity descriptions above vary, but also show consistency. All of them talk about the price at which an instrument or asset can be bought or sold in the market. A less recognized aspect of liquidity is the importance of size. Tempelman (2009) points out that market depth might be a more substantial measure for liquidity than the bid-ask spread. The depth, or available market volume at any one time, is the second parameter for liquidity.

Therefore, we use the following definition on liquidity:

> *Liquidity is the ability to get a price close or equal to the last one, in any instrument, in reasonable size, at any time.*

In which the ability is a descriptive measure, quantifiable using the four dimensions of the IMF: Tightness, depth, immediacy and resiliency. These dimensions represent the trading speed, price and volume. We further explain these dimensions in Section 3.2 and Figure 3.1.

Different asset classes and credit ratings in the fixed income spectrum use different norms of liquidity. While overall liquidity generally deteriorates when moving from Government bonds to High Yield or

Emerging Market Debt, the High Yield portfolio manager already expects an illiquid market. Therefore, the High Yield portfolio manager uses liquidity risks in his bond valuation, while that might not be the case for a Government bond portfolio manager.

3.2 Literature

Several papers researched liquidity and liquidity risks in asset prices and corporate bonds over the past years. It started with liquidity proxies for stocks (Roll, 1984), as daily spread data was available from stock exchanges. Using only daily data, several researchers try to proxy liquidity in corporate bonds (Houweling, et al., 2005) or on stocks (Amihud, 2002; Pastor & Stambaugh, 2003). With the introduction of TRACE in 2004, analysis on the US corporate bond market became a possibility. When a US based corporate bond trade completes, the trader reports the trade within 15 minutes to the Financial Industry Regulatory Authority (FINRA). The FINRA adds the trade to the TRACE database, increasing the transparency and information in the market. Several researchers use this transaction data to analyze the US corporate bond market on liquidity premiums and liquidity risks (Edwards, et al., 2007; Bao, et al., 2011; Jankowitsch, et al., 2008).

In Figure 3.1 we show the four dimensions of liquidity according to the IMF. On the X-axis in Figure 3.1 we identify n_i to represent the total volume in security *i* that could trade. The Y-axis in the same figure, p_i, represents the price against which a certain volume of security *i* could trade. The X-axis serves as the mid valuation in the market, where the *tightness* represents the spread between the bid and the ask. If a portfolio manager wants to buy a security, this occurs versus the ask and the portfolio manager generally pays a markup versus the mid-price. If a portfolio manager wants to sell a security, this occurs versus the bid and the portfolio manager receives a discount versus the mid-price. *Market depth* is the volume that is available at any point in time in the market. Given a certain trading volume, the price will deviate more from the mid. Figure 3.1 shows this as price impact, but the IMF attaches the dimension *resilience* to this absorption potential of the market. The *immediacy* is the speed with which you can trade the specific security in the market.

The transaction costs are a result of the market depth, tightness, resilience (Kyle, 1985) and immediacy (Grossman & Miller, 1988; Harris, 1990; Hachmeister, 2007). Higher volume and a shorter time span correlate with higher transaction costs.

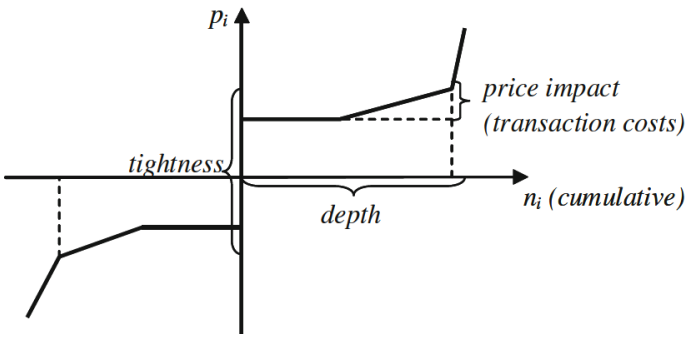

Figure 3.1: Tightness, depth and price impact (Source: International Monetary Fund)

Several papers (Bessembinder, et al., 2006; Edwards, et al., 2007; Goldstein, et al., 2007) report a drop in transaction costs with the introduction of TRACE, as the bid-ask spreads tighten for small and

intermediate sized trades. The researchers translate this into a neutral or positive effect on market liquidity. However, they seem to forget the other dimensions of liquidity as Harris (1990) mentioned. Both Tempelman (2009) and Goldman Sachs (2015) note that overall market liquidity is negatively influenced by increased transparency, even if bid-ask spreads tighten.

The dimensions of market depth, resilience and immediacy are, according to Tempelman and Goldman Sachs, under pressure. The pressure is a result of the combination between increased transparency on one side and the pressures on risk capital and activities of market-makers on the other side.[4] The classic role of market makers was to provide immediacy to the institutional investors by risking their capital. The market maker role changed to an agency role in which they line up the buyer and seller of a certain security. In a view of another investment bank (Deutsche Bank, 2015); dealers were never supposed to acquire capital risk and to keep it on their balance sheets. PwC (2015) however categorizes market makers as intermediaries that facilitate immediacy through their balance sheet, contrasting the agency traders who only provide the service of finding a counterparty. As the current type of dealers are only providing this agency role, their role as risk acquirer might change and "all-to-all" trading venues could see the light in contrast to the over-the-counter market that is in place today (BlackRock, 2014).

In conjunction with the liquidity definition, King (2015) argues that the illiquidity is spreading across markets and manifests in the typically more liquid markets. According to King (2015) electronic trading adds to the phenomenon of the "liquidity illusion". The liquidity illusion argues that there appears to be more liquidity under normal conditions, but the depth of the market evaporates in times of market stress. The illusion becomes visible in the decline of average trade size of European corporate bonds (Appendix B, (PwC, 2015)) and in the index of trading volumes, dealer inventories, on/off-the run and bid-ask spreads (RBS, 2015).

3.2.1 Literature on the measurement of liquidity

To measure the suggested market dimensions from the IMF, a large array of possible proxies have been proposed. No single proxy captures the state of liquidity in itself, but the literature suggests several methods to measure the different dimensions.

Roll (1984) introduces an implicit measure for the effective bid-ask spread. Researchers (Linciano, et al., 2015; Dick-Nielsen, et al., 2012) still use the Roll measure to proxy the tightness in the market. Amihud (2002) expands on this research by providing a price impact liquidity proxy for stocks. Mahanti, et al. (2008) among others use it to proxy the price impact in bonds. Susmel (2014) argues the ILLIQ measure of Amihud is easy to implement as it only requires daily data.

Acharya & Pedersen (2005) present a liquidity-adjusted model of the Capital Asset Pricing Model (CAPM), based on the efficient market theory of Fama (1969). Acharya & Pedersen (2005) question how an asset's expected return depends on relative illiquidity costs, on market returns and on the relative

[4] A result of increased transparency is that every investor can see the previous price that is paid for a bond. Holding inventory penalizes market makers due to Basel regulation. Being unable to return a profit on a bond due to the transparency rules, reduces the capital a market maker is willing to risk. In the agency model, the bid-ask spreads start out tight, but trading a larger volume triggers the price impact effects earlier. This results in a higher volume weighted average price when trying to trade away a larger position in a portfolio.

market illiquidity. They rewrite the one-beta CAPM in net returns in terms of gross-returns to obtain a liquidity-adjusted CAPM for gross returns. Armed with more data, researchers propose new liquidity measures, ranging from price dispersion methods that assess the difference between traded prices and their respective market-wide valuations (Jankowitsch, et al., 2008), to methods that measure the potential liquidity of a bond (Bushman, et al., 2010; Mahanti, et al., 2008). Bao, *et al.* (2011) base their measure of illiquidity on market frictions and on the transitory property of the impact to the market. Acharya, *et al.* (2013) take a conditional approach with two regimes. They conclude that the pricing of liquidity risk follows the state of the economy. The Relative Bid-Ask Spread (RBAS) is another liquidity proxy (van Loon, et al., 2014) which measures a bond's illiquidity premium relative to a liquid bond with identical characteristics on the same day. Van Loon, *et al.* (2014) use the RBAS to model the Credit Spread as a function of bond characteristics. Subsequently, they compute the liquidity premium by calculating the difference between the observed and hypothetical spreads of the perfectly liquid version of the same bond.

Instead of calculating a single measure, researchers have also been looking into several proxies and their explanatory powers. Houweling, *et al.* (2005) consider eight different proxies, whereas Schestag, *et al.* (2014) analyze thirteen different low-frequency proxies based on daily data. Dick-Nielsen, *et al.* (2012) and Linciano, *et al.* (2015) both use the proxies based on the four dimensions by Kyle (1985) to assess bond liquidity.

Supervisors in the financial markets, such as the Bank of International Settlements (BIS), the International Monetary Fund (IMF), the European Security and Markets Authority (ESMA) and the Securities and Exchange Commission (SEC), publish new research prior to releasing new guidelines or regulations. This research ranges from measures to compute liquidity in different markets (Sarr & Lybek, 2002), to market updates from their perspective (Fender & Lewrick, 2015; IMF, 2015) and consultation papers regarding new legislation (ESMA, 2014). The ESMA (2014) paper is a large contributor to future changes in the financial markets due to the proposed MiFID II regulation. In the paper, ESMA suggests two possible measures of measuring bond liquidity under the new MiFID II regulation (MarketsMedia, 2015). These are the Instrument-By-Instrument Approach (IBIA) and the Class of Financial Instruments Approach (COFIA). The IBIA considers the profile of individual bonds to determine whether it is liquid. The COFIA groups individual bonds into classes and determines whether a class is liquid or not.

3.2.2 Perspective

In the literature, academics are trying to capture liquidity by using proxies, models or other types of implied measures. The dimensions research captures are the tightness, depth, immediacy and resilience of the market. These dimensions predominantly represent the bid-ask spread or the transaction cost, as shown in Figure 3.1, and the researchers incorporate some price impact proxies. The proxies use past trade data to provide an explanatory value for the frequently traded part of U.S. corporate bonds.

3.3 Regulatory liquidity measures

Since the financial crisis, regulatory bodies influenced the financial world heavily with risk measures such as the Volcker Rule, constraints on Leverage Ratios and an increase of Risk Weighted Assets. The governing and supervisory bodies are looking to provide new rules to avert a potential liquidity crisis, as

the described liquidity environment in Section 2.1 poses a substantial risk to financial markets. As there is no clear measure for liquidity, the financial regulators are prescribing more qualitative oriented measures and guidelines.

3.3.1 International Monetary Fund (IMF)

In a 2002 working paper, the IMF proposes liquidity measures based on Kyle (1985). The IMF assesses Transaction Cost Measures, Volume-Based measures, Price-Based Measures and Market-Impact Measures, where the translation to liquidity measures is only made for the first three.

Transaction Cost Measures:

$$Spread = \frac{(P_A - P_B)}{\left(\frac{(P_A + P_B)}{2}\right)}$$

Where P_A is the ask price and P_B is the bid price. This spread measure proxies the *tightness* in Figure 3.1.

Volume-Based Measures:

$$Turnover\ ratio = \frac{V}{(S * P)}$$

Where V is dollar volume traded, S is outstanding amount of the asset and P is the average price from the dollar volume traded. The turnover ratio can be used as a proxy for the *depth* in Figure 3.1.

Price-Based Measures:

$$Market - efficiency\ Coefficient = \frac{Var(R_t)}{(T * Var(r_t))}$$

With $Var(R_t)$ the variance of the log of long-period returns, $Var(r_t)$ the variance of the logarithm of short-period returns and T the number of short periods in each longer period. In resilient markets, this number would be slightly below one. In more volatile markets, this number would be far below one. The market-efficiency coefficient proxies the *resilience* or price impact in Figure 3.1.

3.3.2 European Securities and Markets Authority (ESMA)

MiFID II incorporates an assessment on the level of liquidity for non-equity securities and their markets (Ross, 2015). Between two possible choices, the Instrument By Instrument Approach (IBIA) and the Class of Financial Instruments Approach (COFIA), the ESMA currently opts for the Instrument By Instrument Approach after back-testing the COFIA framework resulted in a relatively high proportion of false positives (Preece, 2015).

ESMA defines a bond to be in a “liquid market” if the bond has an average of two trades per day, trades on at least 80% of the available trading days and has a minimum average nominal trade value of €100,000. Waivers can apply when a transaction is for example “large in scale” (LIS) or if the order is

held in an order management facility. The ESMA deem new issuances liquid if it passes the threshold in Table 3.1. ESMA conducts a quarterly reassessment of the liquidity in a specific bond, based on the data of the previous quarter.

			Bond – Liquid Classes
Bond Type	Debt Seniority	Issuer Sub-Type	Issuance Size
Corporate bond	Senior	Financial	Greater or equal to €500.000.000
Corporate bond	Senior	Non-financial	Greater or equal to €750.000.000
Corporate bond	Subordinated	Financial	Greater or equal to €500.000.000
Corporate bond	Subordinated	Non-financial	Greater or equal to €500.000.000

Table 3.1: ESMA liquidity profile

3.3.3. Association of the Luxembourg fund industry (ALFI)

ALFI is the official representative body for Luxembourg fund managers. Luxembourg is the largest fund domicile in Europe[5], positioning ALFI as an influential association. In their guidelines for liquidity risk, ALFI stresses the suggestive nature of their framework.

The guidelines of the ALFI focus on the responsibilities of the management company that manages the UCITS. These management companies should:

- Establish, implement and maintain a liquidity risk policy
- Assess, monitor and review the liquidity risk policy
- Adopt adequate and effective arrangements, processes and techniques in order to measure and manage at any time the liquidity risk which the UCITS they manage is or might be exposed to. Management companies therefore should:
    - Put in place risk measurement arrangements, processes and techniques
    - Conduct periodic back-tests to control the validity of liquidity risk measurement arrangements
    - Conduct periodic stress tests and scenario analyses to address liquidity risks arising from changes in market conditions.
    - Establish, implement and maintain a documented system of internal liquidity thresholds
    - Establish, implement and maintain adequate procedures in the event of breaches of the UCITS risk limit system
    - Manage the liquidity profile of the investments of the UCITS in conjunction with the redemption policy from the management regulation or prospectus
    - When using quantitative models, the reliability of the data should be ensured and the models should be continuously tested

ALFI also proposes several ideas for the management of liquidity risk. In the light of corporate bonds, interesting measures are daily trading volumes, liquidity-adjusted market VaR (where liquidity is

[5] http://www.alfi.lu/about-alfi

represented by the bid-ask spread), the liquidity-adjusted VaR as an adjustment on the market-VaR and a Conditional VaR or Expected Shortfall.

3.3.4 Security and Exchange Commission (SEC)

The U.S. based regulatory body, the SEC, proposed a liquidity risk guideline for institutional investors (SEC, 2015). In a white paper (SEC, 2015), they give an overview of the total U.S. mutual fund market with a focus on the liquidity risks that are prevailing in today's market. While the focus is mostly on equities, the proposed guidelines apply to all open-end mutual funds.

The liquidity risk management program includes multiple elements (SEC, 2015):

- *Classification of liquidity of fund portfolio assets*
- *Assessment, periodic review and management of a fund's liquidity risk*
- *Establishment of a three-day liquid asset minimum*
- *Board approval and review*

The liquidity classification of portfolio assets requires an ongoing review of those assets. Asset managers perform the classification based on the percentage of the portfolio that can be converted to cash within a certain number of days without materially affecting the value of that asset. Several variables or factors would be required to be part of the analysis in the assignment of the liquidity bucket. The SEC proposes six liquidity categories; one business day; 2-3 business days; 4-7 calendar days; 8-15 calendar days; 16-30 calendar days; and more than 30 calendar days.

The liquidity risk definition in use by the SEC is "*the ability of a fund to meet redemption requests under normal or stressed conditions, without affecting the fund's NAV per share".* The SEC places a fifteen percent limit on the illiquid assets that a mutual fund can hold.

The three-day liquid asset minimum requires a fund to determine a certain percentage of the portfolio that falls within the first two liquidity categories.

To validate the process and to determine the height of the measures, the SEC adds "*board approval and review*" to their proposal. The board of the fund thus approves the three-day liquidity minimum, as well as the liquidity risk management procedures.

3.3.5 Perspective

Regulatory measures influenced the financial markets heavily, as can be seen in the Problem Cluster in Appendix A. The ESMA proposal is cautious when we compare it to the SEC outline of providing regulatory instructions for asset managers and their funds. The regulators also have not reached a consensus approach towards liquidity and the management of liquidity risk, as we also see in the literature. Although a consensus lacks between regulators, they prefer to have liquidity management processes in place at institutional investors to prevent the possibility of another crisis. Regulatory focus is on the overall state of the market with the classification of bond liquidity and the liquidity outlook from the market. An index that aggregates the institutional confidence to deal with liquidity issues in the market might help the regulators to do just that.

3.4 Market practices

The financial industry produces research on market developments. The sell-side performs this research to provoke buy side movements, as they profit from the volume and number of flows in the market. In this section, we discuss and describe four market practices on liquidity. We selected these market practices on their variety, their availability and the use in the market by different market players.

The recent spur in liquidity research from both buy- and sell-side firms shows that liquidity is a topical subject in the financial sector and asset management industry. NN Investment Partners[6], Deutsche Bank[7], S&P Capital IQ[8], BlackRock[9], RBS[10], Citibank[11], JP Morgan[12], Janus Capital[13], Natixis[14], among others, have been publishing research on liquidity in one form or another. These updates vary from simple outlooks on regulation or the tasks of an asset manager to deal with liquidity, to lengthy and in-depth research backed by quantitative models.

We assess several quantitative models in this section. First, we show the "*Liquidity Cost Score*" value of Barclays. The second model we discuss is the *"BVAL"* from Bloomberg, followed by the "*Liquidity Score by Issue"* from Citibank. The last model we assess is the "*Risk Analytics Tool"* from Aladdin. We again conclude with a perspective on the presented market practices.

3.4.1 Liquidity Cost Score – Barclays

Dastidar & Phelps (2009) introduce the Liquidity Cost Score (LCS) of Barclays. The LCS value has been designed as the round-trip cost to execute an institutional-size transaction as a percentage of the bond's price. Dastidar & Phelps (2009) define the LCS as follows:

$$LCS = (Bid\ spread - Ask\ spread) * Spread\ Duration \quad (if\ bond\ is\ spread - quoted)$$

$$LCS = \frac{(Ask\ price - Bid\ price)}{Bid\ Price} \qquad (if\ bond\ is\ price - quoted)$$

Spread Duration can be seen as the percentage change in a bond's price for a 1% change in its spread over a Treasury of the same maturity. It represents the bond's price sensitivity to spread changes.

A higher LCS value represents less liquidity and a higher cost to execute a trade. Dastidar & Phelps (2009) acknowledge that the use of the bid-ask spreads does not cover the market impact of larger trades. However, Dastidar & Phelps (2009) defend their method by stating that the LCS value has a high and positive correlation with market impact costs. Thus, larger trades in assets with a high LCS should result in higher trading costs.

[6] NN Investment Partners: Strategy Update Market liquidity in European high yield (05-2015)
[7] Deutsche Bank: US Credit Strategy – Signs of Liquidity Vacuum in Unexpected places (05-2015)
[8] S&P Capital IQ: Lookout Report (07-2015)
[9] Blackrock: Viewpoint – Corporate bond market structure: The time for reform is now (09-2014)
[10] RBS: The Silver Bullet – Sleepwalking into the liquidity Trap (03-2015)
[11] Citi Research: Liquidity Scores by Issue (09-2012)
[12] J.P. Morgan: European Rates Strategy – Market Depth declined when it was mostly needed (05-2015)
[13] Janus Capital: Investment Outlook – It never rains in California (07-2014)
[14] Natixis Asset Management – Liquidity risk in Fixed Income Markets

To produce the LCS, Barclays collects trader bid-ask quotes for either Barclays Capital Credit or High Yield Indices from both the U.S. and European market. Thereafter, Barclays averages the daily LCS values for each corporate bond on a daily basis and then take the average of all days in a given month to obtain a monthly LCS for a particular bond.

The LCS has several limitations. Traders provide the bid-ask indications, but not transactable two-way markets. Therefore, the trader indications might overstate the best bid-ask spread in the market. Also, the inventory or outlook of a trader might influence his bias towards a certain quote. Tighter bid-ask spreads might not represent better liquidity if this is the case. The tightness represented by the trader quotes might improve, but the influence on immediacy and resilience remains unknown.

As one of the biggest sell-side firms, Barclays quotes bid-ask prices for numerous assets. Dastidar & Phelps (2009) perform a cross-sectional regression on the corporate bonds quoted by the Barclays traders. The variables and coefficients in Figure 3.2 are the result of this cross-sectional regression. Dastidar & Phelps (2009) apply these coefficient values to the corporate bonds that are outside the spectrum of bonds quoted by Barclays to also obtain a LCS value In Figure 3.3 Konstantinovsky, *et al.* (2015) show the average market attributes for both the US and European corporate bonds for the month of June 2015.

USD and EUR Corporates: Cross-Sectional Regression Results, June 2015

	Constant	Age	Issue size	OASD × OAS	Volume	USD dummy
coefficient	0.316	0.003	-5.6E-05	0.019	-2.4E-04	0.060
t-stat	(33.59)	(1.65)	(-8.92)	(45.38)	(-8.17)	(6.66)

Figure 3.2: LCS Market Attribute coefficients and significance (Source: Barclays)

Market Attributes Driving Corporate LCS: USD vs. EUR, June 2015

	USD Corp	EUR Corp
LCS, %	0.858	0.412
OASD	6.99	5.19
OAS, bp	144	122
OASD x OAS	11.88	5.67
Avg age, yr	4.4	2.9
Avg issue size, $mn	731	919
Avg volume, $mn	47	39

Figure 3.3: LCS Market Attributes (Source: Barclays)

The significant variables in Figure 3.2 provide a possible indication for usable bond attributes to determine liquidity and liquidity risk. We therefore take notice of the variables "*Trading volume*", "*Issue size*" and "*OASDxOAS*"[15]. Although the variable "*Age*" has a rather large coefficient, it is not significant.

3.4.2 BVAL Score – Bloomberg[16]

Bloomberg is one of the financial platforms that connects financial professionals to each other. As one of their services, Bloomberg constructs the Bloomberg Valuation Service (BVAL). The BVAL Score is an

[15] OASD is the Option-Adjusted Spread Duration. OAS is the Option-Adjusted Spread.
[16] Bloomberg: BVAL "Help"; 27) Calculations

index that combines a number of weighted observations with the standard deviation of those observations to determine the BVAL Price.

Bloomberg states that the BVAL Score is not a liquidity indicator. There is however a possibility that securities with a higher BVAL Score have more market makers providing services. Should a user be able to access those market makers, they may find more liquidity for those securities with higher BVAL Scores as opposed to ones that have lower BVAL scores.

The methodology to construct the BVAL is a combination of "*quantitative models, market insights and data from contributing sources*" to produce a score metric which measures the quantity and quality of market observations supporting each price at each date/time combination.

In the Fixed Income market, the BVAL Scores for Governments, Supranational, Agency and Corporate (GSAC) bonds are a combination of:

1. The Direct Observations (DO) methodology, which uses trades, indicative quotes and executable levels on the target security.
2. The Observed Comparable (OC) methodology uses direct observations on comparable bonds to derive a relative value price for the target security when observable market data on the Target Security is insufficient.

Direct Observations

The Direct Observations algorithm analyses, among others, the institutional size TRACE trades and indicative market quotes from global and regional banks, broker-dealers, and exchanges. Presumably using an autoregressive (AR) model, the data is time decayed and filtered. Bloomberg uses either price or spread over benchmark inputs depending on the asset class to generate a bid, mid, and ask price for a security.

Observed Comparables

The Observed Comparables method uses the characteristics of the asset class and structure of the security to construct the algorithmic approach towards the BVAL Score.

Yield to Maturity Model

- Used in Investment Grade bullet bonds (fixed and floating) across the US GSAC.
- Derives a par issuers curve based on direct market observations across an issuer's term structure. When not enough market observations are available, BVAL creates the reference curve from comparable liquid peers.

- OAS Duration Model
  - Investment Grade callable bonds across GSAC sectors
  - Using the liquid bullet par issuer curve as the benchmark and determines the OAS/Duration of the target callable security. A reference curve can be created from comparable liquid peers.
- Normalized Yield to Maturity Model

- High Yield bonds across Corporate and Emerging Market sectors
- Liquid bonds in an issuer's capital structure are used to create normalized yield to maturity curves at each rank in the capital structure. Comparable bonds can be used to derive a relative price if needed.

Bloomberg not only offers the BVAL Score and BVAL Bid-Ask Spread, but also computes composite prices based on the quoted prices for a corporate bond. If enough data points are available, Bloomberg calculates the Composite Bloomberg Bond Trade (CBBT). When Bloomberg lacks data points, they calculate the Bloomberg Generic Quote (BGN). Schestag, *et al.* (2014) use both the CBBT and the BGN as a liquidity proxy and for the larger trades, the CBBT proxy outperforms several other proxies.

3.4.3 Liquidity score by Issue – Citi[17]

Citi uses a 5-factor model to give a liquidity score to a specific security, identified with a Committee on Uniform Security Identification Procedures (CUSIP) number. Citi uses the following liquidity factors: the absolute number of trades, the clustering of trades, the quality of trading activity, the diversity of trades and the volatility.

Absolute number of trades: Citi counts the number of block trades for each CUSIP over the most recent 60 trading days. A block trade is defined as more than $5 million in the Investment Grade environment and more than $1 million in the High Yield Environment. A higher number of block trades for a specific CUSIP translates to a more liquid environment.

Clustering of trades: A credit event could prompt a flurry of activity. This is not equal to the liquidity on an "average" day. The clustering of trades counts the number of different days on which at least one block trade took place. A CUSIP with consistent block trades over the past 60 trading days is more liquid.

Quality of trading activity: A CUSIP with more client activity is consistent with a higher quality of trading according to Citi Research. Citi measures the quality as a ratio of trades of end-client buys and sells versus all trading activity. Citi adds a weight to the quality ratio by multiplying with the clustering of trades. A higher number of end-client buys and sells represents a better liquidity. End-client activity is an indicator of client activity and the ability trade the CUSIP, resulting in a more liquid issue.

$$\frac{Client\ sells + client\ buys}{Total\ number\ of\ sales} \times \frac{Days\ with\ a\ block\ trade}{Trading\ days} = Quality\ of\ trading\ activity$$

Diversity of trades: A close balance between end investor buying and selling interest can be a sign of a more liquid bond. Citi measures the difference between client buys and sells as a percent of the total client activity. As with the quality of trading activity, Citi adds a weight to the diversity ratio by multiplying with the clustering of trades. A higher diversity of trades indicates a liquid issue.

$$\left(1 - \frac{(client\ sells - client\ buys)}{(client\ sells + client\ buys)}\right) \times \frac{Days\ with\ a\ block\ trade}{Trading\ days} = Diversity\ of\ trades$$

[17] Liquidity Scores by Issue – Citi Research North America

Volatility: All else equal, Citi research believes that the risk-transfer is likely to increase if an issue is stable. Citi assigns a volatility score using their proprietary mark-to-market risk, based on the spread volatility[18]. Citi ranks each issue based on a scale of 0% to 100%, with 0% being the most volatile and 100% being the least volatile. Citi assigns this score based on the spread volatility of the issue. In an example, Citi states that a bond with a spread volatility of 17 basispoints obtains an 88% score for the volatility metric.

Each factor attributes a weight to the liquidity score. Citi uses the separate CUSIP score to compute a liquidity score per sector, giving a positive, negative or neutral fundamental view. These sectors are for example Insurance, Transportation or Utilities. In terms of the IMF dimensions of liquidity, the Citi Liquidity score tries to analyze the depth of the market and the quality of that depth.

3.4.4 Liquidity Risk analytics – Aladdin by BlackRock

Investment professionals use the Aladdin operating system as an end-to-end investment platform. BlackRock, an asset manager and the company behind the Aladdin system, develops and expands on the operating system to support client decision making. One of the recent developments in Aladdin is the Liquidity Risk Platform, providing insight in the liquidity of the portfolio and the transaction costs that can be expected when an individual bond or a total portfolio is sold.

The Aladdin platform is a portfolio construction and measurement environment. The platform acts as an operating system to manage money in real time. Inside the Aladdin platform ratings are given for an array of liquidity indicators. These can be either qualitative or quantitative. A liquidity tier and asset class designation is the more qualitative approach. For the quantitative view, Aladdin focusses on a Transaction Cost model, as shown in Figure 3.4.

The platform provides a portfolio liquidity profile report with information on the costs of:

- Liquidating the portfolio over different time horizons
- Partially liquidating a portfolio
- The number of days needed to liquidate the portfolio without exceeding certain levels
- A stress scenario, such as increased volatility or a reduction of market depth.

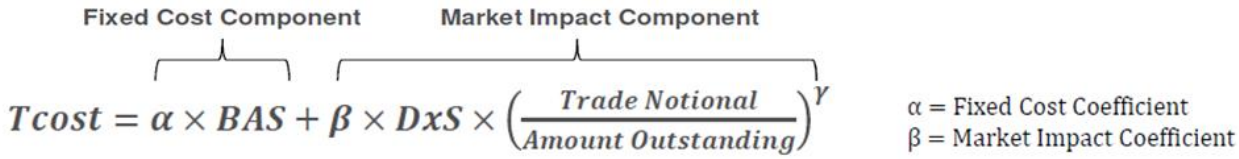

Figure 3.4: Aladdin Liquidity Portfolio Risk Tools (Source: BlackRock)

The Transaction Cost (Tcost) model for corporate bonds has two major components, the Fixed Cost Component and the Market Impact Component. Both components can be seen in Figure 3.4. In the Fixed Cost Component of the Transaction Cost model in Figure 3.4, the *BAS* is the Bid-Ask Indicator and the α is the Fixed Cost Coefficient. In the Market Impact Component in Figure 3.4, the β is the Market

[18] Citi Risk pricing and probabilities of default (2011)

Impact Coefficient, the *DxS* is the Duration times Spread of a security, the *Trade Notional* is the trade volume and the *Amount Outstanding* is the total issue amount of the security. Aladdin states that they calibrate the *γ,* the *α* and the *β* in the model such that expected costs closely match the realized costs.

The Fixed Cost component is a function of the Bid-Ask Indicator (*BAS*) for the corporate bond. Aladdin estimates this Bid-Ask Indicator for corporate bonds using the Spread Duration, the Option Adjusted Spread (OAS), the Amount Outstanding, Age, and the Deviation from Par of the corporate bond. Aladdin only specifies the signs of these variables on the BAS and remains opaque on the weights for each of the previously mentioned variable in the calculation. Older bonds, bonds with higher Duration Times Spread (DxS), lower outstanding amounts and bonds priced further away from par have higher bid-ask spreads.

The Market Impact Component in the Tcost model in Figure 3.4 is a function of the *Duration times Spread* and ratio of the *Trade Notional* and *Amount Outstanding*. The *Amount Outstanding* is a fixed variable for a corporate bond; the *Trade Notional* varies with every planned trade. The *Duration times Spread* is the sensitivity to a relative change in spread for the specific corporate bond. A credit that has a wider spread tends to experience greater spread changes (Dor, et al., 2007). Aladdin calibrates the coefficients (α, β and γ) with an average quote of top 20 contributors. Aladdin also runs a second calibration, comparing the model bid-ask spread over the last 22 days to actual transactions.

In Figure 3.5 is the basic visualization of the transaction costs. The example in Figure 3.5 is likely to be a representation of government bonds, as the total transaction cost for a €20 million trade is around 3 basispoints. However, the calculation in Figure 3.5 is redundant; the focus should be on the rationale. The rationale is that the Transaction Cost model is an econometric model which shows an increase in costs when we want to trade a larger size. The calculation takes the IMF dimensions of *depth*, *tightness* and *resilience* into account for each corporate bond in a portfolio.

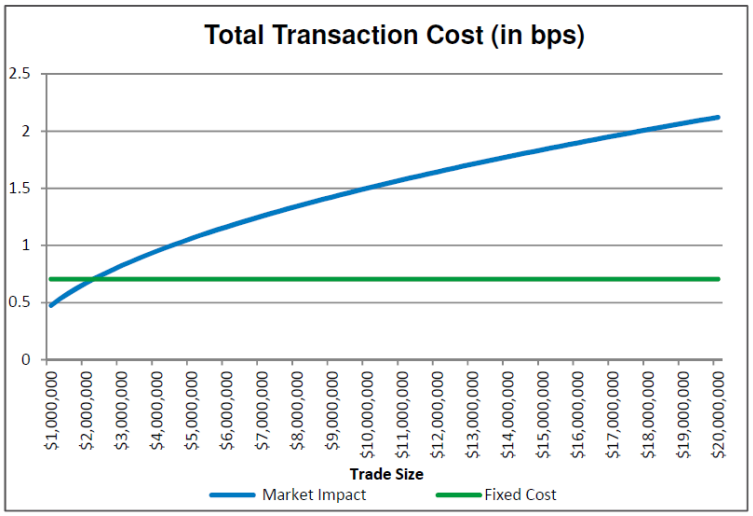

Figure 3.5: General dimensions of transaction costs calculated in Aladdin (Source: BlackRock)

3.4.5. Perspective

For the repetitiveness of an article, academics mostly use the historical dataset from TRACE or the quoted end of day prices from Bloomberg. The sell-side researchers have an advantage due to their

proprietary quotes and trading data. An example are the Barclays trader quotes of approximately one-third of the market. While the level of analysis can be high with sell-side research, the sell-side firms make money by producing trading volume in the market. For the buy side a correct analysis of the liquidity per bond in terms of volume, price impact and execution time would be preferred. This liquidity analysis allows for better portfolio management and a reduction of total trading costs.

In terms of the econometric model, the use of variables by market participants is the following:

	Barclays (LCS)	Aladdin (Tcost)	Citi (Liquidity Score)	Bloomberg (BVAL)
Age	x	x		x
OASD x OAS or DxS	x	x	x	x
Amount Outstanding	x	x		
Trade Volume	x	x		x
US Dummy	x			
Deviation from Par		x		
Block trade count			x	
Non zero trade days			x	
Spread volatility			x	
Diversity of trades			x	

Table 3.2: Comparison of variables in econometric analysis of Liquidity by market participants

We can see in Table 3.2 an overview of the different liquidity calculations from the market participants. The Citi score is a deviation from the standard and will be omitted in the rest of the paper due to the lack of data on single corporate bonds. The important liquidity indicators from market perspective seem to be *Age*, *Duration times Spread, Amount Outstanding* and *Trade Volume.* The calculations for the LCS, BVAL and Tcost remain opaque, but the variables in the econometric models are similar. In terms of IMF dimensions, the liquidity calculations largely try to cover the *tightness* and *depth* of the market. The Tcost model of Aladdin also tries to measure the *resilience*.

3.5 Overview of liquidity principles

In this chapter, we discuss liquidity from a regulatory, market and theoretical perspective. From these perspectives we can state that liquidity is fluid, it is ever changing, it varies with the bond characteristics, the side you want to trade, and it is hard to quantify.

For both regulators and market participants, liquidity represents well-functioning markets. It is the ability to trade with the other side and to meet future liabilities with ease. Although the stakeholders want roughly the same, there is no agreement on how to measure liquidity. If the liquidity models want to add any value, they should be forward looking to support decision making. This directly corresponds with the difficulties of liquidity, as the models use historical data to predict the future.

For regulators, the ideal liquidity metric is an indication of how well the financial markets work in general. Only defining which security is liquid on issuance is not sufficient as liquidity varies during the lifetime of an issue. A Market Liquidity Index (MLI) that is a monthly, backward looking, survey of both the buy and sell-side on their liquidity experiences would be a possibility. As an addition to the

qualitative MLI survey across the asset managers, a report can be constructed with important market statistics such as the net in- or outflows in funds, the heterogeneity in market participants for asset classes, the level of overall stress in the market and the total trading volume.

Market participants form a heterogeneous group, with different concerns from the buy and sell side. The end investors of buy side asset managers and mutual funds want to reduce the transaction costs when investing or divesting and avoid the risk of a 'fire-sale' of their investments. The ideal liquidity metric for the buy side is the *cost to transact* for a *given volume of an issue*. The *time frame* should also be considered, where the period varies between a few hours to one or more days.

For academics, liquidity is a combination of four different characteristics, the tightness, depth, resilience and immediacy. The empirical research shows the use of proxies and daily historical trading data to represent these liquidity dimensions. Finding useful proxies to represent the market liquidity based on available data improves the information distribution in the market, making them more efficient.

We show an overview of these preferred liquidity measures in Table 3.3.

Actor	Preferred liquidity measure by actor	Contains parameters
Regulator	A Market Liquidity Index (MLI) of some sorts	Net fund flows
		Market participants
		Market stress level
		Daily trading volumes
Buy side	Transaction costs for a volume of an issue in a certain time frame	Price
		Volume
		(Exposure) Execution Time
Academic	A model to forecast probable liquidity and risk based on several attributes or factors	Depth
		Tightness
		Immediacy
		Resilience

Table 3.3: Preferred Liquidity measure

3.5.1 Transparency

In the U.S. corporate bond market, TRACE provides market transparency since 2004. The immediacy and the depth of the market allegedly suffered as a consequence, while the American corporate bond market is larger than the European market. The MiFID II plans from the ESMA to introduce TRACE-like transparency will influence the bid-ask spreads and the depth of the corporate bonds. The transparency penalizes market-makers, resulting in a brokerage only function for market makers and eliminating an important market participant in Europe.

4. Measuring liquidity

In this chapter, we look at several methods to measure liquidity. First, we calculate the proxies from the literature to assess the IMF dimensions of liquidity. We follow different papers, specifically Dick-Nielsen, *et al.* (2013), as an example to calculate the liquidity proxies with the TRACE data set. We take a time period from 2007Q3 until 2012Q4 as the Enhanced TRACE function is only available until the end of 2012. This means that we analyze the American Corporate bond market for this time period, in order to obtain a general outlook of the liquidity proxies.

Next to that, we also calculate liquidity with the market practices presented in Section 3.4. To calculate these market practices, we use three model portfolios of NN Investment Partners for the period of September 2013 until September 2015. Again, the constraints are with the available data.

We conclude the chapter with a comparison of the three portfolios on the market liquidity scores. Due to the data limitations, we are unable to perform a comparison on the academic proxies with the market practices.

4.1 Modelling the dimensions of liquidity

We follow the studies of Dick-Nielsen, *et al.* (2013), Sarr & Lybek (2002) and Linciano, *et al.* (2015) to analyze the academic liquidity proxies. We cover the IMF dimension of *resilience* with the Amihud liquidity, the *tightness* dimension with the Round Trip cost and the *depth* dimension with the Turnover Ratio and Zero Trading Days. We first present the measures and their rationale. Then we graphically present the results over the period.

We use the Enhanced TRACE dataset, using several bonds characteristics. We retrieve bond characteristics on timing, side of the trade, reported price, volume and the identification in the CUSIP. We perform the analysis on data from the second half of 2007 until the end of 2012, as that covers the full financial crisis and runs until the end of the Enhanced TRACE data set. The R code we use to process can be seen in Appendix C. After trimming down the bonds we are left with 12.460 bonds for which we request additional data via Bloomberg on issued amounts.

4.1.1 Price impact

We present the Amihud illiquidity measure as a representation of the price impact on the American corporate bonds.

Amihud Illiquidity

As an ordinal measure of price impact, Amihud (2002) proposed the ILLIQ measure. The Illiquidity measure started out as a price impact measure for stocks due to the availability of data. Several corporate bond researchers recently employed the ILLIQ measure to investigate the price impact of trades on those bonds. Dick-Nielsen et al. (2012) slightly modify the initial Amihud ILLIQ measure to the following:

$$Amihud_t = \frac{1}{N_t}\sum_{j=1}^{N_t}\frac{|r_j|}{Q_j} = \frac{1}{N_t}\sum_{j=1}^{N_t}\frac{\left|\frac{P_j - P_{j-1}}{P_{j-1}}\right|}{Q_j}$$

Where N_t is the number of returns on day *t*, Q_j is the quantity or traded volume in millions at the specified return *j* and P_j and P_{j-1} are the trade prices. At least two transactions are required on a given day to calculate the Amihud measure for illiquidity. We define a monthly Amihud measure by taking the median of daily measures within the month.

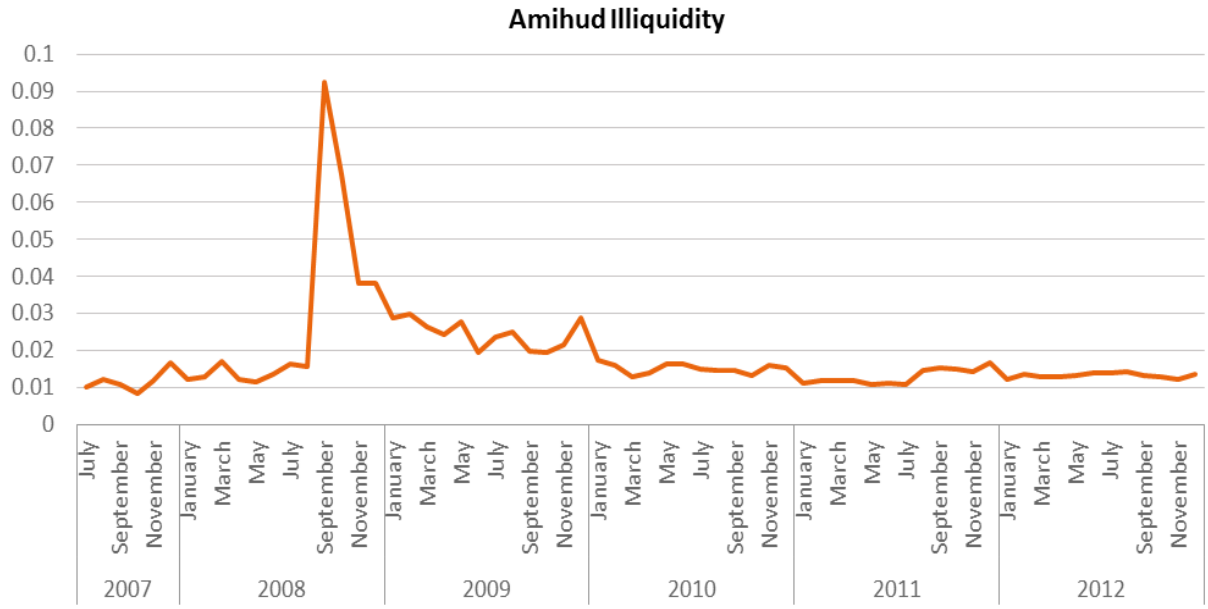

Figure 4.1: Amihud Illiquidity (Source: TRACE data, 2007Q3 - 2012Q4)

The Amihud measure of illiquidity should be interpreted as the price reaction to a traded volume and as a relative measure throughout time. As visible in Figure 4.1, the effect has been the largest during the financial crisis in the US. In the year 2010 until 2012, the illiquidity measure stayed marginally above the level of 2007, with a small increase during the European sovereign crisis in the second half of 2011. This higher ILLIQ measure suggests a small increase in the illiquidity in the American corporate bond market since 2007.

4.1.2 Tightness

We represent the IMF dimension of *tightness* with an Adjusted Round Trip Cost, based on the Imputed Round Trip of Feldhütter (2012).

Adjusted Round Trip Cost

Feldhütter (2012) proposes an Imputed Round Trip cost as a calculation between the highest price and the lowest price in a short time period. This is data intensive and as we use Enhanced TRACE, it is possible to retrieve the direction of a trade together with the volume and the reported price. This means we can adjust the original Round Trip Cost by Feldhütter (2012) to incorporate these trade directions. Following the rationale of the LCS from Barclays, we adjust the Round Trip Cost to:

$$Adjusted\ Round\ Trip\ Cost\ (ARTC) = \frac{P_S - P_B}{P_B}$$

Where P_S is the reported price in TRACE of a sell by a market-maker or broker and P_B is the reported price when a market-maker buys a certain bond. Negative ARTC are possible, representing a haircut for the market maker.

In Figure 4.2, we see the average monthly Adjusted Round Trip Cost in basis points. Following Feldhütter (2012) we calculate the Adjusted Round Trip Cost by taking the average of the daily round trips in a specific bond. We again average these daily values over the month.

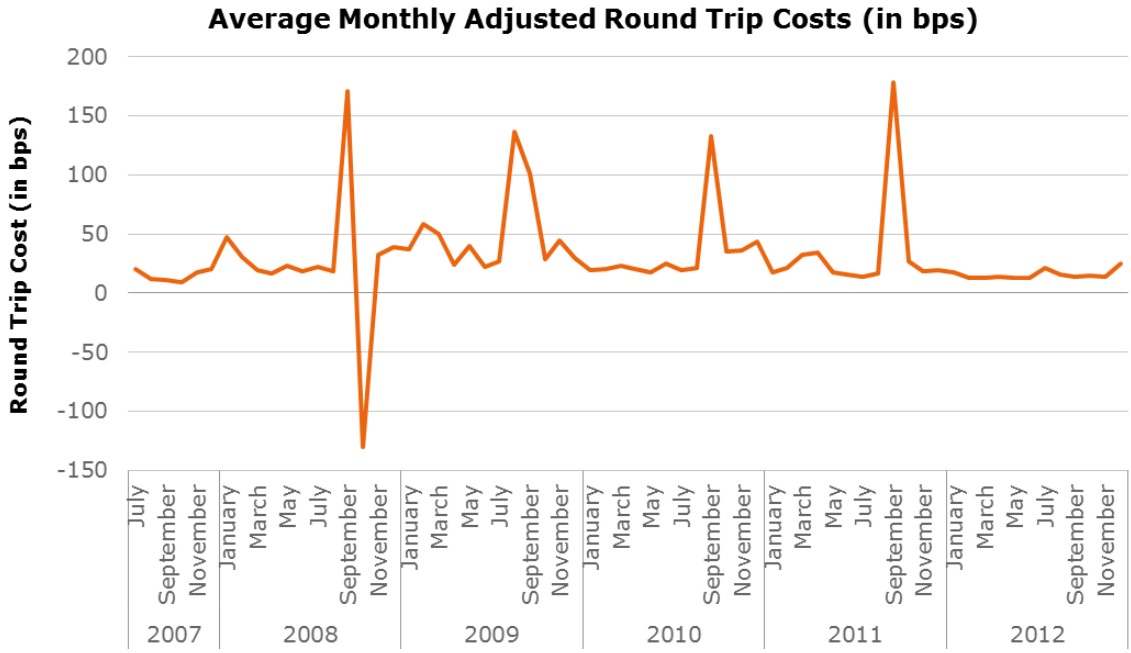

Figure 4.2: Average Monthly Adjusted Round Trip Cost (Source: TRACE data, 2007Q3 - 2012Q4)

The results in Figure 4.2 are in basispoints. The Adjusted Round Trip Cost represents the price difference between the procurement and sales of a corporate bond, as a percentage of total bond price. Generally, the market makers obtain a mark-up during a crisis to compensate for the risk they take. In October of 2008, when the financial crisis hit, the market makers had to sell their corporate bonds on a discount.

4.1.3 Trading activity

To proxy the *depth* of the market, we calculate the average monthly Turnover Ratio and the percentage of Zero Trading days in a month.

Turnover ratio

The Turnover Ratio is the traded volume of a bond as a ratio of the outstanding amount of that bond. A higher Turnover Ratio for a specific bond indicates that it trades frequently. A higher Turnover Ratio does not imply that it trades close to the last price, as an increase in traded volumes may also coincide with stress events. The Turnover Ratio is the following:

$$V_t = V_{i,d} = p_{i,d} * \frac{TV_{i,d}}{AO_i}$$

Where $p_{i,d}$ and $TV_{i,d}$ are the price and the traded volume of bond *i* on day *d* and AO_i is the amount outstanding of bond *i*. The bonds for which we calculate the turnover value have a minimum issue amount of $100mn and the traded volumes are at least $100.000. We show the results for the American market from the second half of 2007 until the end of 2012 in Figure 4.3.

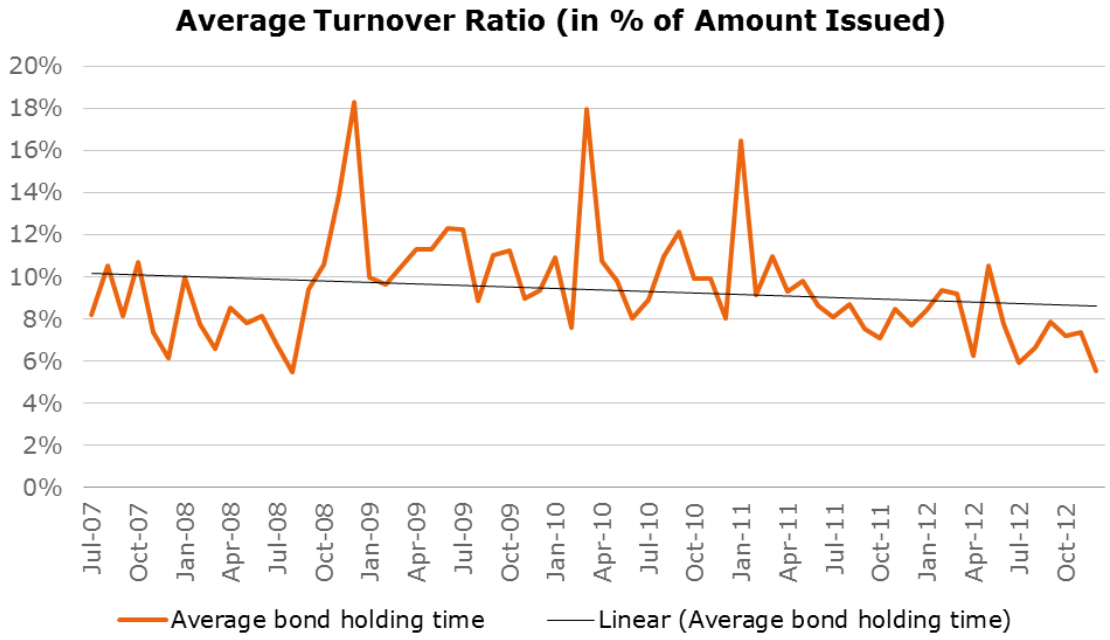

Figure 4.3: Turnover ratio in the bond market (Source: TRACE data, 2007Q3 - 2012Q4)

In Figure 4.3, we see an average monthly Turnover Ratio of around 10%. The 10% Turnover Ratio represents an average holding time of 10 months for a bond. Periods with higher turnover correspond with periods of more stress in the financial market. If we omit the stressed periods, we observe a decline in the average Turnover Ratio, indicating an increase in holding time of an average bond.

Zero Trading days

Another indicator for the *depth* of the market is the percentage of Zero Trading days in the market for a corporate bond. We capture trading frequency by:

$$Z_i = \frac{NZR_i}{T_i}$$

Where Z_i is the Zero Trade day statistic equal to the percentage of days with no trading, NZR_i is the number of non-zero trade days in month *i* and T_i is the total number of trading days in month *i*. An increase of Z_i represents a decrease in bonds that trade during a month. To calculate the Zero Trading days, we first omit the US holidays and weekend from the monthly business days to obtain the trading days for each month. We then divide the total days on which a bond traded during a month by the number of working days. When a bond did not trade during a month, its value is zero. We present the results for this Zero Trading day statistic in Figure 4.4.

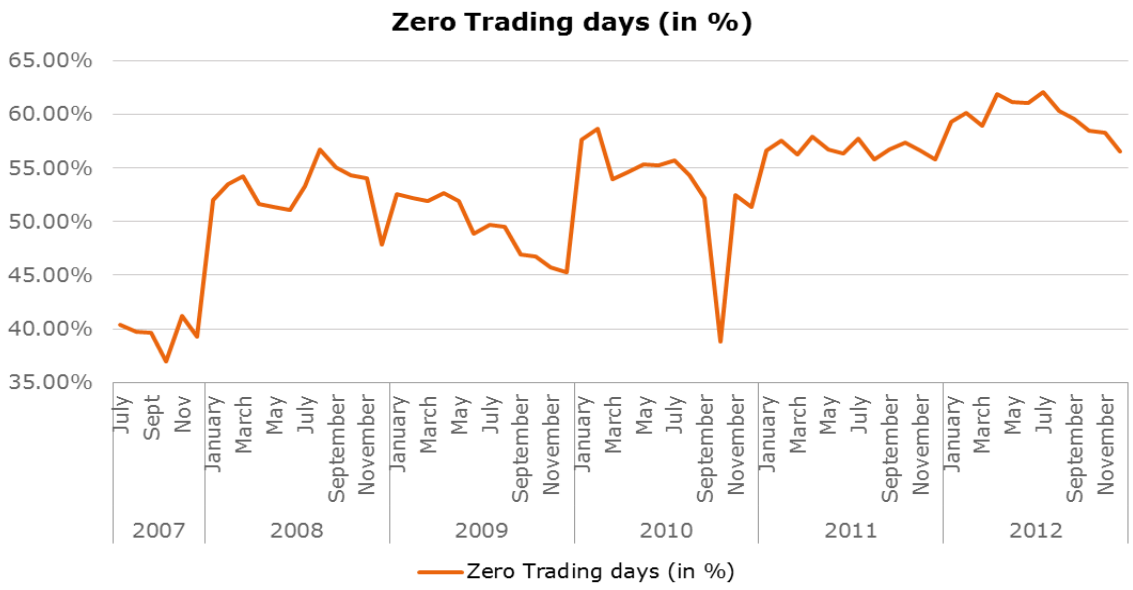

Figure 4.4: Zero trading days, in % (Source: TRACE data, 2007Q3 – 2012Q4)

The percentage in Figure 4.4 shows the percentage of bonds that did not trade in that specific month. At the start of our analysis in the second half of 2007, only 40% of bonds did not trade during a month. Near the end of 2012, this number increased to 56% of all bonds. Figure 4.4 shows that a large part of the corporate bond spectrum does not trade. This lack of trading might make it difficult to pinpoint a correct price valuation.

4.1.4 Concluding from the proxies in literature

Proxies in the literature have explanatory value on the historic transaction cost and show the general liquidity environment. We give an overview of these correlations in Table 4.1. The low correlation scores indicate that these academic liquidity proxies do not move together. As the proxies try to explain the different IMF dimensions, this seems plausible. An increase in the Illiquidity measure shows no response in the corresponding period for the Zero Trading days.

Pearson Correlation – Academic proxies

	Zero Trading Days	Turnover Ratio	Round Trip Costs	Amihud Illiquidity
Zero Trading Days	-	-	-	-
Turnover Ratio	-0.173	-	-	-
Round Trip Cost	-0.066	0.049	-	-
Amihud Illiquidity	-0.037	0.248	0.110	-

Table 4.1: Pearson Correlation of Academic measures

The liquidity proxies we present are backward looking and analyze historical data. However, we want to be able to give an indication of the future costs to our clients to indicate fair transaction costs, in normal and stressed times.

4.2 Liquidity costs from market calculations

In order to assess the market practices presented in Chapter 3, we use the market practices to compare a European and Global High Yield portfolio and a European Credit portfolio. We follow the described methodologies from sell-side researchers to quantify the trading costs. We use the values from the LCS of Barclays, the Transaction Costs of Aladdin and the BVAL from Bloomberg. We omit the Citi Liquidity Score as we have insufficient data to construct it.

4.2.1 Proprietary portfolios

We compare the European High Yield, the Global High Yield and the Euro Investment Grade portfolios on a market weighted valuation. We compute the market value of the positions in the portfolio and weigh the positions accordingly with the liquidity values from the sell-side research. Take note that the graphs containing values and numbers from these model portfolios are limited by the data available for these portfolios. The portfolio statistics were consistently available since September 2013.

In general, the European portfolios focus on Euro denominated bonds and the Global portfolio targets around 70% US bonds and 30% EU bonds. The High Yield portfolios target bonds with a rating of BB+ and lower and the Investment grade portfolio focuses on BBB- and higher. To get a further feeling of these portfolios, the characteristics as of 9/30/15 are in Figure 4.5.

Figure 4.5: Portfolio characteristics of Global and European HY and Euro IG (Source: NN Investment Partners)

4.2.2 LCS – Barclays

We present the LCS methodology in Section 3.4.1. Barclays calculates the LCS on a monthly basis for both the European and the American corporate bond market. In Figure 4.6 we show the LCS values for the Barclays indices on European and American corporate bonds**.** These indices represent the whole credit rating for the specified region and show the LCS value for the normal sized round trip trade. The normal size is €1 million for High Yield and €5 million for Investment Grade. We extract the LCS values from the portfolio construction tool of Barclays, POINT.

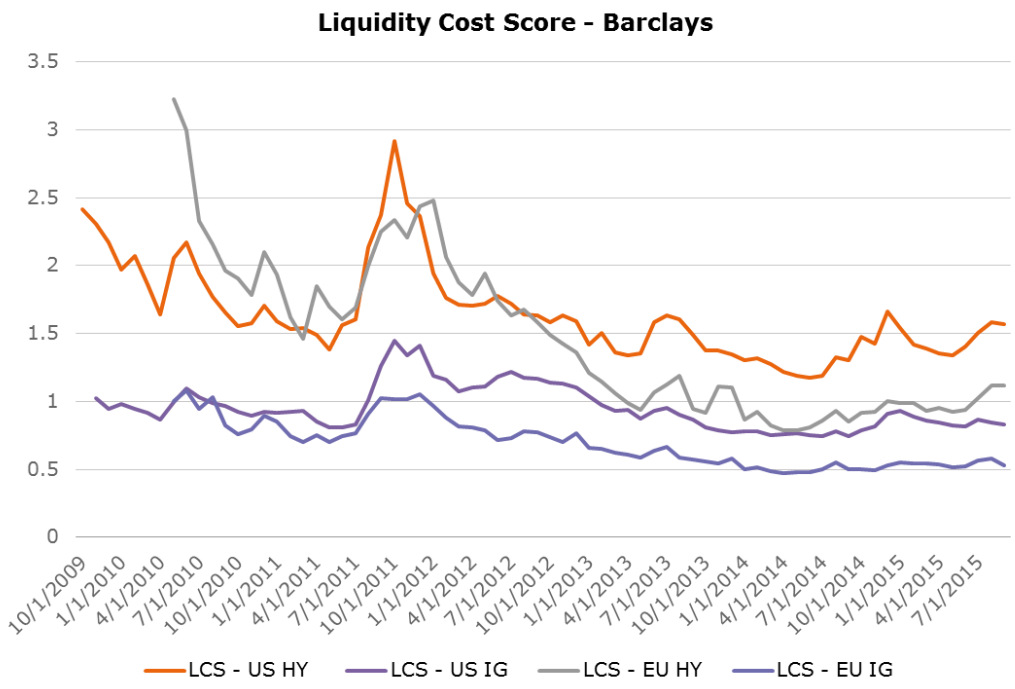

Figure 4.6: LCS by Barclays for both US and EU (Source: Barclays POINT)

If we observe the LCS values from both the US and the EU, the LCS values seem to move together. Using Pearson's Correlation, we find that the correlation varies between 0.674 and 0.958. These high correlations indicate that the LCS values move together. It might suggest that either one of the given Liquidity Cost Scores causes the other one, or that they depend on some other variable such as overall market conditions. We present the correlations Table 4.2.

Pearson Correlation – Barclays LCS

	US High Yield	US Investment Grade	EU High Yield	EU Investment Grade
US High Yield	-	-	-	-
US Investment Grade	0.780	-	-	-
EU High Yield	0.800	0.674	-	-
EU Investment Grade	0.855	0.765	0.958	-

Table 4.2: LCS Correlation Matrix

Coming back to the methodology behind the LCS, the correlation matrix shows that trader quoted bid-ask spreads will widen and tighten together. If markets get stressed, the quoted bid-asks will widen, which results in a higher LCS and a higher costs to trade. Vice versa applies when volatility decreases.

Model portfolio LCS values

The graph in Figure 4.5 shows the aggregate level of the LCS over the total market per credit rating and geography. In Figure 4.7, we compare the LCS values of the three model portfolios over the period September 2013 until September 2015.

Figure 4.7: LCS values of three different funds over a two-year horizon

The methodology we use to calculate the LCS values for the model portfolios is the following: We take the holding percentage of a specific corporate bond in the portfolio and multiply the bond with the LCS value from Barclays. As Barclays is unable to provide the LCS value for each bond, we multiply the portfolio positions that obtain a LCS value with the inverse of the total portfolio that obtains a LCS value.

The percentage of a portfolio that obtains a LCS value can be seen in Figure 4.8. For example, a Global High Yield position that has a LCS value at 9/30/2013 is multiplied with **x**. This creates a fully weighted LCS value for the portfolio that we can compare over time.

Figure 4.8: LCS values available for % PF Market Value

We create a breakdown of the three model portfolios by age, both on the percentage that is in the portfolio by market weights and the average LCS value inside a certain age bucket, which represents the years until maturity. It becomes visible that in the investment grade area, the investment strategy is a classic one with a higher liquidity 'premium', as represented by the LCS, than the shorter duration issues. The high yield portfolios are more contrarian in their setup, buying issues that have a certain story. Comparing the numbers to the overall LCS values as described in Section 4.1.1, the high yield portfolios are on average a bit more illiquid and the investment grade portfolio is less illiquid.

The Liquidity Cost Score is classified in age buckets in Appendix D. Each proprietary portfolio has an age bucket that represents the time to maturity. These are in Figures D1, D3 and D5. These portfolio percentages give a sentiment on how firm the LCS values are in the bar chart for each maturity bucket.

4.2.3 Transaction Cost model – Aladdin

The Transaction Cost model in the Green Package of Aladdin describes the current cost to liquidate a full position. The Transaction Cost model is also able to simulate partial, or pro-rata, sell-offs. In Figure 4.9 we show the total liquidation cost of the three model portfolios from 4.2.1 and two additional portfolios, an Emerging Market Debt and a Euro Fixed Income strategy. The size of the bubbles in Figure 4.9 reflects the size of the fund. If we value these portfolios against the mid-market price and want to liquidate it, the costs to do so consist of a Fixed Cost component and a Market Impact component. We summarize the costs for both components in Table 4.3 for all five portfolios.

Figure 4.9: Liquidation costs in basispoints (size of bubbles reflects fund size (Source: Aladdin, 9/30/15))

Table 4.3: Liquidation costs in basispoints (Source: Aladdin, 9/30/15)

The Fixed Cost component represents the bid-ask spread that is necessary to cover the spread from the mid valuation of a corporate bond to the ask or bid valuation. The Market Impact component represents the movement of the bond price as a result of trading that particular bond. More details on the

Transaction Cost model can be found in Section 3.4.4. In Figure 4.10 we show the total liquidation costs of our model portfolios in basispoints over various time horizons.

Figure 4.10: Total portfolio liquidation costs over various time horizons (Source: Aladdin, 9/30/15)

Model portfolios Transaction Costs

To reduce the liquidation costs of a portfolio, the holdings in the model portfolios have a bid-side valuation. Therefore, the full liquidation costs of the model portfolios should only consist of the Market Impact component. We take this bid-side valuation into account for the rest of the Aladdin Transaction Cost Model. We present the Market Impact liquidation costs in Figure 4.11. The reduction in total liquidation cost correlates with the removal of the Fixed Cost component, as we value the portfolios versus the bid-side.

Figure 4.11: Market impact liquidation costs over various time horizons (Source: Aladdin, 9/30/15)

We present a further dissection of the Market Impact component by Aladdin. Aladdin provides both liquidation costs over a time horizon and over a partial cross-section of the portfolio, known as pro-rata. The time horizon variable offers a 1-day, 5-day and 10-day liquidation cost analysis. The pro-rata liquidation cost analysis varies from 5% to 25% of the portfolio on a 1-day horizon.

As it is highly unlikely to have a full liquidation of a normal portfolio in 1-day, we calculate a pro-rata assessment over the three time horizons for our model portfolios. We use this calculation to obtain insight in the time effect on the market impact of liquidating a specific portfolio. The calculation method is the following. We start with the pro-rata calculations for the various portfolio sizes. We then calculate a time horizon ratio of the liquidation cost decrease over the 1-day to the 5-day horizon and the 1-day to the 10-day horizon. Finally, we multiply these time horizon ratios with the 1-day pro-rata liquidity cost analysis.

The full overview of the results can be found in Appendix E. In Table 4.4 we present the liquidation costs for the European High Yield portfolio. The liquidation costs are in basispoints. For example, when liquidating 25% of the European High Yield fund spread out over 10 days instead of 1 day, the liquidation costs go down from **x** basispoints to **x** basispoints.

Table 4.4: Market Impact liquidation (Source: Aladdin)

In Appendix E we also add the investment costs, which we calculate by adding the full bid-ask spread to the pro-rata assessment.

Stress scenarios using the Transaction Model

We follow up on the pro-rata assessment with two scenarios of market stress. Aladdin offers this analysis as an addition to their Transaction Cost model. Following the pro-rata assessment, the stress

scenarios also value the portfolios against their bid. A remark on the stress scenario we present is that it uses historical data, which is unlikely to hold in a true stress scenario.

We show the two scenarios in Figures 4.12 and 4.13. Figure 4.12 shows the market impact liquidation cost when the market volatility increases with 30%. The 1-day cost to liquidate the European High Yield portfolio increases from **x** basispoints to **x** basispoints. This increase is also visible for the other model portfolios when we compare it to Figure 4.11. Figure 4.13 shows the market impact liquidation cost when the market depth decreases with 50%. The increase in the 1-day liquidation costs for Global High Yield portfolio is relatively high when we compare it to the increase of the European High Yield portfolio. This is likely due to the total fund size of the Global High Yield portfolio, as visible in Figure 4.9.

Figure 4.12: Market impact liquidation costs with increased volatility (Source: Aladdin, 9/30/15)

Figure 4.13: Market impact liquidation costs with reduced market depth (Source: Aladdin, 9/30/15)

4.2.4 BVAL – Bloomberg

The Bloomberg Valuation Service provides two values. The first value is a score on a ten-point scale (0-10), with a higher possibility of finding liquidity if the BVAL score is higher. In Section 3.4.2 the methodology behind the BVAL score can be found. The second value that we can obtain from Bloomberg is the BVAL Bid-Ask values, which aggregates the available bid and ask-quotes for securities in Bloomberg on specific dates.

In Figure 4.13 we present an overview of the market weighted BVAL scores for our model portfolios. Every holding in the portfolio obtains a portfolio weighted BVAL score and we add these scores to acquire an aggregate BVAL score for a portfolio on a given date.

Figure 4.13: BVAL scores (Source: Bloomberg)

Our model portfolios seem quite stable in terms of their BVAL Score. The difference between a BVAL of 8 and 9 is hard to distinguish. We therefore add an overview of the percentage of total holdings in a portfolio that get a BVAL Score of 5 or below. The graph in Figure 4.14 represents a percentage of issues that have a low BVAL score out of the total number of issues.

Figure 4.14: Percentage of the portfolio with a BVAL score below or equal to 5 (Source: Bloomberg)

The percentage of low BVAL scores stays under 5%, indicating that it should be possible to find trading activity for most of the underlying securities in these portfolios.

The BVAL Score is not the only available liquidity indicator from Bloomberg. Bloomberg also provides an average of the trader-quoted bid and ask prices. We follow the LCS methodology of Barclays as

presented in Section 3.4.1 and the academic *tightness* proxy of the Adjusted Round Trip Cost as presented in Section 4.1.2.

Similar to the LCS method of Barclays, we take the bid and ask quotes Bloomberg provides and calculate a Round Trip Cost. We calculate the aggregate Round Trip Cost for a portfolio similarly to the LCS of Barclays, weighing each Round Trip Cost to the market value of the specific holding.

Figure 4.15: BVAL Bid-Ask Round Trip Cost (Source: Bloomberg)

In Figure 4.15, we see the BVAL Round Trip Costs for our model portfolios. The Global and European High Yield portfolios seem to move together. The Euro Investment Grade shows smaller price movements and has been increasing since the start of 2015.

4.3 Evaluation of academic proxies and market practices

We present several academic and market practices throughout Chapter 4. In this section, we evaluate the measures and provide additional remarks. We start with the academic proxies and follow up with the market practices for the three model portfolios. We compare the market practices on correlation and standard deviation for the model portfolios.

Academic proxies

We use the academic proxies to cover the IMF dimensions of *tightness, depth* and *resilience.* We calculate the *resilience* with the Amihud measure, the *depth* with both the Turnover Ratio and Zero Trading Days and the *tightness* with the Adjusted Round Trip Cost. According to the Pearson correlation of the proxies, the proxies show little interaction. While the independence might hold in a normal period, in stressed periods we would assume that the *resilience* and *tightness* would both suffer.

The Adjusted Round Trip Cost shows similarities with the Barclays LCS calculation. They represent only the bid-ask spreads, but can be used as a first indicator for the costs to buy bonds in the secondary market. The percentage of bonds that do not trade during a month is remarkable. The increase of 40% to 55% of the corporate bond spectrum shows a deteriorating trading environment over the years 2007-2012. For all these academic proxies the disadvantage of a backwards looking measure remains.

The model portfolios

In terms of LCS, the three funds perform close to the market practice. Diving in on Appendix D and the LCS per age bucket values, it is observable that the Euro IG has a positive sloping LCS throughout the maturity buckets and over the years. For the European HY fund, both the majority of the portfolio as the highest LCS values can be found in the **x** to **x** years to maturity buckets. When looking at the Global HY fund, we see a reversal when comparing 2013 to 2015. In 2013, the LCS values went up as the maturity went up. In 2015, the LCS values were higher for the issues with a shorter time to maturity.

Aladdin recently implemented the Transaction Cost model and therefore lacks data points to compare the values with either the LCS or the BVAL. The time horizon component and the forecasting ability justifies further investigation. The total liquidation costs for the full portfolios might not represent the

true size of the market impact, but it is possibly a value to measure the costs. That market impact reduces with time is a variable that is not observable in any other liquidity calculation. The pro-rata investment and redemption costs with different time horizons indicate the cost savings that can be achieved for a total trading volume in a specific time horizon.

The BVAL Score is seems to be a redundant score. Only a small percentage of the issues scores below a BVAL Score of 5. With the BVAL bid-ask quotes, we have the opportunity to perform our own Round Trip trade, incorporating the rationale behind the LCS and the Adjusted Round Trip Cost. The BVAL Round Trip Cost and the LCS of Barclays both have the same time period from September 2013 until September 2015. We perform a Pearson Correlation to analyze the level of interaction between the two market practices. The correlation matrix can be found in Table 4.5.

Table 4.5: Correlation between Barclays LCS and BVAL Round Trip Cost over 09/2013 – 09/2015 (Source: Barclays, Bloomberg)

Table 4.5 shows the correlations between the different model portfolios for both the LCS and the BVAL Round Trip Cost. We would expect the same portfolios to move together. Remarkably, the LCS value for Euro Investment Grade has the highest correlation with the BVAL bid-ask quotes of European High Yield. The lowest correlation can be found in the combination of the BVAL Euro Investment Grade and the LCS calculations of European and Global High Yield.

5. Liquidity Risk for portfolios

In Chapter 3 we describe liquidity, as a concept, through a definition and by giving an overview of the market practices and literature perspectives. In this chapter, we investigate the liquidity risk and the management of that risk. Through the calculation of this liquidity risk, we provide insight in the risk that remains in the portfolio when a fund manager is unable to unwind a position in a timely manner.

First, we discuss the liquidity black hole. Then, we present a measure to incorporate liquidity costs in a risk management model. Finally, we give an example from our model portfolios.

Liquidity Black Hole

One of the problems in the market for financial assets is that, when one financial institution decides for whatever reason that it wants to unwind a position, it is often the case that many other financial institutions with similar position decide they want to do the same thing. The liquidity normally present in the market then evaporates. This is known as the "liquidity black hole" phenomenon. (Hull, 2012) This phenomenon has been an increasing worry for the financial market and the regulators. (Wolzak, 2015)

In the imagined run-to-the-door scenario, the price change that follows from new information on a security exaggerates the price impact of that information. Due to the speed with which information is spread and the commonality in market practices from asset managers, herding behavior (Roubini, 2015) emphasizes the first price movement that results from the new information. Consequently, the new price of the security then does not reflect the correct market valuation. The result of this incorrect valuation is a fire sale, in which the market behaves irrational on the new, non-representative, price.

5.1 Liquidity Risk Measures

Normal risk management scenario's only account for the value that is at risk. We expand on the standard Value at Risk (VaR) model with a liquidity component. Subsequently, we apply this new measure to our High Yield model portfolios.

5.1.1 Liquidity-Adjusted VaR

One of the possibilities to measure the cost of unwinding positions in a normal market is to make use of the combination of the Value at Risk measure, a commonly used Risk Management measure, and liquidity, represented by the bid-ask spread. The suggested bid-ask spread and liquidity measure is comparable to the Spread measure (IMF, 2015) and is also presented by Hull (2012). The Liquidity Adjusted VaR then becomes:

$$L - VaR = VaR + \sum_{i=1}^{n} \frac{s_i a_i}{2}$$

With s_i equal to the proportional bid-offer spread and a_i as the dollar or mid-market value of the position. We calculate the proportional bid-offer spread s_i as follows for the bond *i*:

$$s_i = \frac{offer\ price - bid\ price}{Mid\text{-}market\ Price}$$

In a stressed scenario the resulting factor is an increase in volatility. This impacts the liquidation period such that the liquidity-adjusted VaR also represents the cost of unwinding the position under stressed conditions:

$$L - VaR_{stressed} = VaR + \sum_{i=1}^{n} \frac{(\mu_i + \lambda\sigma_i)a_i}{2}$$

With μ_i and σ_i as the mean and standard deviation of the proportional bid-offer spread for the financial instrument *i*. The λ gives the one-way confidence interval, multiplying the standard deviation with the statistic that follows from the distribution for the 95% or 99% confidence level. Especially the stressed theoretical model assumes the absence of heteroskedasticity and uses either historic or analytical models. Both the lack of tail events and the assumption of a constant volatility bias the results to a normal distribution instead of the representation of the real world values (Hull, 2012).

In comparison, the relative liquidity cost $L_t(q)$ in percent of the mid-price for an order quantity of *q* at time *t* can be split into three components according to (Ernst, et al., 2009):

$$L_t(q) = T(q) + PI_t(q) + D_t(q)$$

Where T(q) are constant direct trading costs including exchange fees, brokerage commission, and transaction taxes, $PI_t(q)$ are the price impact costs of order quantity *q* at time *t* as the difference between the transaction price and the fair price, and $D_t(q)$ are delay costs if a position cannot be instantly traded. In their piece, Ernst et al. (2009) omit both $D_t(q)$ and T(q). While for institutional investor T(q) is an acceptable simplification, neglecting $D_t(q)$ is more problematic. The delay cost influences a position heavily in the case of a 'fire-sale', the event for which the liquidity-adjusted VaR is being calculated, as is emphasized by (Stange & Kaserer, 2009). However, incorporating this forced delay cost into a model is beyond the scope of this paper, so the focus will be on the price impact costs as a model for the liquidity-adjusted VaR.

5.1.2 Alternative model for L-VaR

In order to give an insight in the Liquidity-Adjusted VaR for the securities in a portfolio, we compute the L-VaR measure from the monthly individual VaR and a monthly liquidity score. We take the VaR from the Green Package of Aladdin, allowing a portfolio overview of the VaR for both historical and analytical VaR levels. We use the Barclays LCS as a liquidity measure, representing actual round trip trades in the market to represent the cost of liquidating the position. As a model, the difference to the theoretical model of both Hull (2012) and the IMF (2002) is in the usage of the LCS from Barclays. The LCS-VaR that we compute here is percentage based, as both the historical VaR and the LCS were calculated on a relative basis.

$$LCS - VaR_i = VaR_i + \frac{\frac{TA_i - TB_i}{TB_i}}{2}$$

With TA_i as the average trader ask price for a security and TB_i as the average trader bid price for the specific security. The TA and TB are used to compute the total LCS of a round trip trade. We divide the LCS in two, as it assumes a mid-market price between the bid and the ask.

5.1.3 High Yield portfolios

To portray the use of the LCS-VaR, the holdings position of the Global High Yield fund of a real asset manager is used. The fund consists of around 70% US corporate bonds and 30% European corporate bonds that are rated BB+ and below from S&P or Ba1 and below from Moody's. Both the LCS and the VaR of these securities are extracted from the data sources explained above and combined for a monthly LCS-VaR rating for the individual issues and the portfolio. In the graph below, the dispersion of the LCS-VaR for the Global High Yield portfolio is given at an individual security level, not weighted for market value. The weighted versions of LCS-VaR for both portfolios in terms of market value can be seen in Appendix F. The LCS-VaR value is backward looking for one month and can be calculated for a shorter or longer period by using the square root of the number of trading days. For example, multiplying the LCS-VaR by $\sqrt{2}$ gives an approximation of the two month LCS-VaR.

Table 5.2: Global High Yield **Table 5.3: European High Yield**

Combining the historical 99% VaR and LCS score, we are creating a possibility to sell the whole portfolio in a relatively stressed market with a calculation of the maximum haircut. However, in a normal market and less stress conditions, the one way LCS is a better indication of the transaction costs in that situation.

In Table 5.2 we give the summary information on the Global High Yield fund, the average of both the VaR and the LCS of the fund. As described in Chapter 3, BlackRock also computes the transaction cost for liquidating a position. For the Global High Yield fund, we present the cost to fully liquidate the portfolio as a sum of both the market impact and transaction cost in Appendix F, Table F1. The difference between the Barclays one-way LCS measure and the Transaction Cost from Aladdin for the Global High Yield portfolio is that a single trade with the LCS is expected to cost **x** basispoints on average, and that the full cost to liquidate the Global High Yield portfolio is **x** basispoints according to Aladdin. We give the European High Yield fund as a comparison, with a further dissection of LCS-VaR values available in Appendix F, Figure F2.

The advantage of using a liquidity-adjusted Value-at-Risk based on both the LCS from Barclays and the Portfolio Risk tool of BlackRock's Aladdin is that it gives users their market data, allowing for an empirical and current analysis of the portfolio. Other data in the OTC market is scarce, for both average bid and asks, as holds also true for the traded volume.

6. Portfolio management in a changed liquidity environment

Portfolio managers of open-ended and mutual funds have to manage the changed liquidity environment as presented in the previous chapters. A consensus on a quantitative approach to liquidity has not yet been reached in the literature or the market. As a qualitative method, interviews can be applied in financial markets to supplement the knowledge that is available on the perceived liquidity mismatch (Tuckett, 2011). In order to gain further insight in the perceived mismatch, we will interview professionals who work in the financial i.

We start with the construction of a classification system to weigh the suggestions of the interviewed financial professionals. The interview setup and the classification system are to be presented first, using the arguments from the problem context in Section 2.1. We then evaluate the classification overview using the interviews. An interpretation of the evaluation follows, supplemented by remarkable anecdotes and experiences from the interviews.

Before we move on to the setup of the interviews, take into consideration that we identify two scenarios for liquidity in an asset class. The stressed period and the normalized period. The conditional approach from Acharya and Pedersen (2005) as described in Section 3.2.1 provides further explanation on this issue.

6.1 Interview setup

We use a semi-structured interview approach with guiding questions to interview the market professionals. The key area of interests are the current and future liquidity environment, and the current market practices to deal with that liquidity environment. The key participants in the interviews are portfolio managers of corporate bond funds. Other market participants are market-makers, inter-dealer brokers, platform providers, regulators and issuers.

We construct the list with guiding questions after consultation with several portfolio managers and a look into the draft Terms of Reference of Andy Hill (2014) for his ICMA study (Hill, 2014). The guiding questions can be found in Appendix G. We conduct a total of 18 interviews, with a total of 20 financial professionals. The interview candidates included portfolio managers, traders, regulators, risk managers, market innovators and researchers. The participants were from both the buy- and sell-side, from 15 different companies and the combined portfolio managers covered around €34 billion. A little over a third of the participants were actual portfolio managers. The primary business region for all the participants is Europe. Some of the portfolio managers could invest in sterling and one or two are allowed to invest a limited percentage of their portfolio in U.S. names.

6.2 Classification overview

We construct the classification overview with the input from portfolio managers and with the market views published by sell-side researchers. We assign a score varying from -3 to 3 to the propositions in the classification overview that we discuss during the interview. The number of scores we assign as the result of an interview can vary, as some we will cover more topics during some interviews than others. To account for this deviation, the total number of scores that is given to a proposition is also mentioned

in the classification overview in Section 6.5. To be able to show the variety of the market participants in their opinion, we add the standard deviation for each proposition.

The scores from -3 to +3 give a gradual scale that incorporates both positive as negative views. The value -3 translates to "very negative and useless" and +3 is "very positive and useful". The meaning of "useful" here is a combination of how likely and how desirable a proposition is. A highly desirable, but very unlikely proposition will receive a value of -1 or 0, depending on the context. If we skip a proposition during an interview, no value is assigned. If we find the proposed action to be intriguing with regards to the normal or the stressed situation, we specify the implications.

The classification system itself consists of two dimensions, see Appendix G. The top level indicates which level should act on the liquidity environment. The bottom level centers on the actions to be taken by the specified entity.

6.3 Top level of the classification system

The regulator can be identified to be any party with the public task to control or supervise financial markets. Apparent examples are the International Capital Markets Association (ICMA), the SEC in the U.S. and the ESMA in Europe. Domestic regulators such as the Autoriteit Financiële Markten (AFM, Netherlands) or the Commission de Surveillance du Secteur Financier (CSSF, Luxembourg) are also part of this supervisory level. We further assume that the regulatory propositions are to be accepted on a global level or at least in the developed market to prevent regulatory arbitrage.

The fund industry associations represent the financial institutions. Examples are the "*Association of the Luxembourg Fund Industry"* or the "*Irish Funds Industry Association*", as the majority of UCITS funds domicile here. These bodies represent the fund industry when talking to regulators and can propose codes of conduct for fund managers. The market level also consists of other stakeholders in the financial market. Among these other stakeholders are hedge funds, sovereign wealth funds, innovators, trading platforms and market makers from investment banks.

The individual level consists of mutual fund managers and other institutions, such as pension funds or insurance companies, with a fiduciary duty towards their end-client. These institutions employ the portfolio managers that experience the mismatch between the underlying liquidity environment and the end-clients who want to redeem their money.

6.4 Bottom level of the classification system

We present further details on the top level of the classification system in this section. The propositions are a combination of market research and suggestions during the interviews by the market participants.

6.4.1 Regulatory level

The financial crisis was a vocal topic during the interviews on liquidity. Sell-side researchers indicate that the regulation following the crisis is one of the critical factors for the reduced liquidity in the market. Regulators currently identify the liquidity issues, but are still contemplating on the possible policies to deal with the liquidity problems. The regulatory suggestions vary, from other investment vehicles to bringing back auction schemes.

Queues to exit or notification period

A "*queue to exit"* is a waiting period to exit or enter a fund. As end-clients demand daily redemptions for their investments, the fund industry standard is to offer them. If the regulator limits the options for daily redemptions through these "*queues to exit*" on certain benchmarks, then fund managers have more time to fulfill in the clients' needs, and to prevent possible fire sales.

Alternative Investment Vehicle

The UCITS investment vehicle is designed with retail clients in mind. A recommendation could be given to adjust the less liquid asset classes that currently fall under the UCITS framework into a longer term investment vehicle. The European Long Term Investment Fund (ELTIF) emphasizes on the long term investments in the real economy and accommodates less liquid investments than the UCITS structure.

Auction schemes

A corporate bond auction is a pre-determined trading moment for the corporate bond. These auctions occur at specified intervals to increase bid and ask volumes, and the ability to find the correct price. Instead of trading a corporate bond throughout the day, trading might be limited to once or twice a day.

Contrarian participant

A possibility would be for the regulator to act as the missing contrarian party in the market during a stressed scenario. The stressed scenario considers asset class wide outflows, when there would be no counterparty in the market or the natural counterparties are unable to meet the supply. The market, in this case, is already down significantly with no positive outlook.

Liquidity classification

Regulators prescribe that institutions have a liquidity classification process and review that process frequently. Regulators can impose limits on the illiquidity holdings in a mutual fund and then these limits would prevent liquidity and redemption problems for mutual fund managers.

Modifying regulation

The main driver for reduced liquidity is the regulation caused by the financial crisis. Regulatory adjustments that would enable market makers to partially regain their earlier role as lubricant in the market, were suggested in the interviews. A suggestion would be to *"net positions"* in comparable securities. A *"net position"* is the deduction of a long position with the volume of the short position in a similar security. The charge on risk weighted assets is for the absolute volume of a market-maker.

6.4.2 Market level

The market experiences the effects of low liquidity in the fixed income and corporate bond environment. Several market participants warned about the problems with corporate bond liquidity, identifying alleged causes and temporary remedies. See Section 3.4 for an overview. The suggestions for market level solutions vary, from trading platform innovations to changing the role of a buy-side participant.

Contrarian market participant

In a stressed period with outflows from the asset class of fixed income and corporate bonds, the only natural contrarian party currently in place are hedge funds. Only a few possibilities remain, because most of the market participants behave similarly due to the same type of regulation. Sovereign Wealth Funds or other non-regulated market participants might have the resources and the long term view to accommodate the risk appetite needed in a stress period.

Alternative multilateral trading facility

"Multilateral trading facility" is the term for a financial trading venue that is not an exchange. Companies such as Algomi, Neptune, Liquidnet and MarketAxess launch trading platforms that improve the possibility to connect to other market participants. In normal periods these platforms improve the possibility to connect to any other counterparty, through either a dark pool or through a matching algorithm that indicates recent trading activity. In stressed periods or other occasions when all the investors move the same direction, it is unlikely to find a counterparty through these platforms.

All-to-all trading platform

An *"All-to-all trading platform"* connects all financial institutions to each other. Buy-side institutions obtain a connection to the inter-dealer broker market, known as "The Street", and are able to conduct trades with all eligible parties. The all-to-all platform supports buy-to-buy side trades, but allows every financial institution to participate in the market.

Standardized bonds

The corporate bond market offers a wide variety of bond characteristics towards issuers. The possibility to find a counterparty in the same issue increases if the market reduces the variety of bond characteristics, decreases the number of outstanding issues per issuer and increases the amount issued per bond.

6.4.3 Individual level

Institutional asset managers are currently the liable party in the mismatch between the redemption possibilities under the UCITS regulation and the underlying liquidity environment in the corporate bond market. Individual portfolio managers have already been taking precautionary measures to counteract the liquidity effects. The actions vary from taking on more cash to incorporating swing pricing.

Cash

Portfolio managers hold a percentage of cash to service daily outflows. This percentage varies with market outlook and the type of end-clients in a portfolio. Institutional clients tend to have a longer investment horizon and can be serviced with a smaller portion of cash.

Credit Default Swap (CDS) and Credit Default Swap Index (CDX)

A CDS is an option to insure yourself against the probability of default of a corporation. The price of the option rises when the probability that a company defaults increases. It gives a portfolio manager the possibility to trade away the risk of holding bonds from a certain issuer. The CDX moves as an inverse of the total index, as it swaps away the risk for the particular index to default.

Liquid bucket

Portfolio managers create a liquid bucket to be able to service future outflows. This bucket is created by holding the more perceived liquid names. When a portfolio manager look for the more liquid issues, they tend to look at characteristics such as rating, benchmark status, size of the issue, age and the number of investors that follow the bond.

Buy and Hold portfolios

Adjusting the wishes of the client towards a buy and hold portfolio presents a possibility of omitting the liquidity problem. The portfolio starts out as a sorted bucket of securities, in which only the matured bonds have to be refinanced.

Yield to call

"Yield to call" are bonds close to their maturity. These bonds pay their initial value back to the investor in the near future, providing cash to service outflows or to reinvest.

Contact with end-clients

Asset managers have a fiduciary duty towards their end-clients and therefore advise clients on the best market conditions. Close contact with end-clients and exchanging information on possible flows could improve the positioning of a fund. Larger clients can be informed through personal contact of sales agents, for smaller clients or orders a distributor driven notification system would be preferable.

Swing pricing

Swing pricing is an anti-dilution levy to protect current investors from the transaction costs caused by moving investors. Several methods are available to apply swing pricing. A mutual fund manager can choose to charge every in- and outflow or to charge on an absolute flow level. In either case, the investors pay a swing factor over the flow. An asset manager employs a partial swing if there is a minimum threshold of trading volumes before the manager incurs the swing factor. An asset manager employs a full swing if any level of absolute trading flow receives a swing.

Investment limits

Investment limits on bond issues and corporate issuers can limit single name exposure. To service normal period outflows, the liquidation of a small amount can be absorbed by the market. In general, investment limits correlate with the perceived risk levels of a bond, where lower rated bonds tend to be less liquid than higher rated bonds. The investment limits try to reflect these risks by setting a maximum investment percentage.

Soft closing of funds

The size of a fund is an indication of the potential to move between positions. The size of a fund consists of the absolute size and the relative size to the investment spectrum. While larger funds offer economies of scale in terms of management and obtainable fees, they also become riskier for end-investors with regard to liquidity. With a larger fund, the absolute volume positions to obtain the same returns also become larger and more difficult to move away from. The closing of a fund for new investors might therefore be a possibility for asset managers to fulfill their fiduciary duty.

Gating

In a stressed period and within the UCITS fund structure, a mutual fund manager has the possibility to lock down a fund and suspend the NAV calculation. Redemptions then go through a *"gate"*, where everyone who wants to redeem joins a queue and the fund manager pays the investors pro-rata. This is the main method recognized by the Commission de Surveillance du Secteur Financier (CSSF)[19] to deal with stressed periods.

6.5 Classification results

In this section, the results of the interviews are in Table 6.1. As a reminder, the spectrum is from -3 to 3 and we add both the standard deviation of the score and the number of interviews in which we discussed a specific subject. A standard deviation of more than 1 shows a varying opinion, a standard deviation below 1 translates to a more homogenous judgment.

	Average Score	Standard Deviation	Mentions
Regulatory level			
Queues to exit	2.56	0.50	9
Alternative Investment Vehicle	-1.33	0.47	3
Auction schemes	2.00	0.00	1
Contrarian participant	0.50	2.06	4
Liquidity classification	-2.33	0.47	3
Modifying regulation	0.77	0.70	13
Market level			
Contrarian market participant	0.00	0.89	10
Alternative multilateral trading facility	0.81	1.33	16
All-to-all network	1.47	1.38	17
Standardized bonds	-1.00	0.91	12
Individual level			
Cash	2.60	0.66	10
CDS or CDX	1.83	0.69	6
Liquid Bucket	1.80	0.75	10
Buy and hold portfolio	1.00	1.58	4
Yield to call	2.00	0.00	2
Contact with end-client	2.50	0.50	10
Swing pricing	2.67	0.47	12
Investment limits	2.13	0.60	8
Soft close of funds	1.43	0.73	7
Gating	-2.29	0.70	7

Table 6.1: Classification results from the interviews (Source: Financial professionals)

[19] Luxembourg Financial Markets Supervisor, the domicile of the majority of UCITS funds

Throughout the next sections, we give the results for the different ideas and propositions. In the headline, the subject and the average score for the particular subject is shown. As stated in the introduction of this chapter, we omit the propositions without any noteworthy remarks.

6.5.1 Regulatory level

The inclusion of the regulatory level in the interviews is low when we compare it to the other two levels. We discussed two topics with the majority of the financial professionals, the "*queues to exit*" and the *"modification of regulation*". We omit a further explanation on the *"auction schemes"* as only one interviewee brought up the subject.

Queues to exit (2.56)

Asset managers identify that queues to exit could mitigate the mismatch by removing the ease of redeeming the funds. Nonetheless, being the first mutual fund manager to introduce the queues would be detrimental to the reputation of the fund. It is similar to the classic prisoner's dilemma in game theory, as no one asset manager will introduce extended waiting lines to exit their funds. End-clients request daily liquidity and a fund manager offers daily liquidity. Asset wide regulation removes the barrier to install queues to exit, as the queues become mandatory.

Alternative Investment Vehicle (-1.33)

The introduction of the ELTIF as a dedicated long-term investment vehicle is "*everything one would ever want from a new vehicle*" according to a product developer. The score is negative for the three interviews in which we broached the subject. The issue with moving your UCITS stamped fund towards an ELTIF and implementing longer redemption periods is similar to the initial "*queues to exit"* problem. The fund industry as a whole needs to adopt the strategy, otherwise it is more rewarding to offer the UCITS structure with daily redemptions.

Contrarian participant (0.50)

The Central Bank as a contrary participant obtained some sympathy, but also harsh critics. One of the interviewees named it "*Interfering with the market in that way is more a Chinese method"*. Other participants saw the merits in the stress scenario, as central banks are the only market participant that can leverage their books.

Liquidity classification (-2.33)

The liquidity classification in the proposal of the ESMA (Section 3.3) is only a bureaucratic layer towards securities that cannot be defined as such. "*You can't be as vague as to say something is liquid, every bond has its own characteristics",* as one of the participants described it. In a stressed period, if you have market wide outflows, liquidity is nowhere to be found and regulatory categories will not change the liquidity of a bond.

Modifying regulation (0.77)

Most participants identified regulation as one of the main causes of the current liquidity environment. The regulation reduced the capital risk function of market makers, reducing the *immediacy* in the market. Participants agreed that the aggregate effect of the regulation is excessive and that scaling down the regulation would certainly help liquidity. Some interviewees argued that the market is now

more normal than before the crisis. Together, the participants were positive on a more lenient approach for market makers, but wary of the chances to accomplish a change in regulation.

6.5.2 Market level

The topic that connects all the interviewees is the financial market. As the participants cover every aspect of the market, the deviation from the average score is high when we compare it to the individual and regulatory level. We discuss all the market level propositions and different viewpoints in the next section.

Contrarian market participant (0.00)

The financial professionals mentioned the necessity of a contrarian party to make a market. However, Solvency II and Basel III stipulations only leave market participants such as hedge funds and sovereign wealth funds as a possible counterparty. According to the interviewees, hedge funds lack the capital to absorb the potential outflows from the fixed income asset class. Additionally, the perceived risk appetite of sovereign wealth funds is the deal breaker for these funds to act as a counterparty.

Alternative Multilateral Trading Facility (0.81)

The opinions on the different trading facilities and innovations varied, as indicated by a standard deviation of more than 1. Almost every participant agreed that the adoption of an alternative trading platform would come in the following years, but were uncertain on the timing and the platform. According to one of the traders, the buy side is particularly poor in organizing themselves and for example choosing a specific platform to employ. This might mean that none of the platforms is adopted, which removes a possibility to find some liquidity in the near future. The alternative platforms should "*not be seen as the all-end solution to liquidity"* according to one of the PM's, but as one of the possible ways to find liquidity.

Another interesting remark is the following: "*the market is less of a market than everyone thinks, which holds in particular for the High Yield market*". In the Investment Grade spectrum, smaller trades of around one to three million execute via e-trading. In the High Yield spectrum and the larger volume trades in Investment Grade the market-makers tend to work orders, putting up a sharper price for the first half of the trade and obtaining the exclusive right to find a counterparty for the second half.

A regulatory risk to using dark pools comes from the pre-trade transparency requirements in MIFiD II. This pre-trade compliance would make it impossible to use a dark pool, unless it falls under the waiver of MIFiD II. The exact consequences of MiFID II will pan out over the course of 2016.

All-to-all network (1.47)

Participants noted that the diminishing use of capital risk by market makers diminished their role as being the middle men and liquidity providers in a trade. Especially portfolio managers sympathized with the idea of an all-to-all network, portraying that it realizes more price discovery and more information in

the market. The largest asset manager in the world, BlackRock, already connected to this inter-dealer market.[20]

Yet, in times of market stress and asset wide outflows, all fund managers want to sell bonds and more trade possibilities will not help if there is no counterparty.

Standardized bonds (-1.00)

Portfolio managers encouraged the idea of a more standardized bond issuance and benefit it would have to liquidity. However, the general view is that standardization appears unfeasible. The freedom of corporate issuers to choose their own size, maturity and type of bond outweighs the benefit to secondary market liquidity in the corporate bond market.

6.5.3 Individual level

Since asset managers have been dealing with the reduced liquidity environment for a while, the majority of the suggestions incorporate the individual level. We review several suggestions on the individual level, ranging from gating to cash.

Cash (2.60)

The most widely accepted and used manner to mitigate the in- and outflows in a fund is to hold a higher level of cash. These cash levels differ between mandates and more publicly available funds. For client mandates, portfolio managers maintain a cash level of approximately 1% in the Investment Grade space to seize opportunities from new deals. In a publicly traded Investment Grade UCITS fund, cash levels can move up to 4% to 5%. The High Yield mandates hold a cash level of around 4% to 5% and could increase to 10% depending market views and whether the fund trades publicly or not.

Liquid Bucket (1.80) & CDS or CDX (1.83) & Yield to call (2.00)

Portfolio managers use liquid buckets, CDS and CDX crossovers, and yield to call bonds as cash alternatives. The majority of the interviewed portfolio managers used liquid bucket. Yet, the possibility remains that these observed liquid bonds freeze up during stressed periods, as everyone tries to sell their liquid bonds to service outflows. CDS and CDX will go up in value in a market down turn, as the probability of default increases. Therefore, these derivatives can be sold during volatile times to free up cash, providing default protection from specific names or the index. Yield to call bonds are an uncommon cash alternative. Similar to the liquid bucket, it depends on other parties during any market stress and hence the yield to call bonds carry more risk than cash.

Contact with end-client (2.50)

Among most of the asset managers, contact with the larger end-investors is in place and portfolio managers receive a timely notification if large fund flows occur. Although the influence of flow movements from the retail investors has grown over the past years, the dialogue on their investment intentions is almost non-existent. Smaller funds and portfolio managers with a smaller client base successfully advised their end-clients to hold off on moving when the markets were volatile, preventing

[20] http://www.bloomberg.com/news/articles/2015-07-15/blackrock-s-latest-fix-for-bond-trading-is-circumventing-banks

unnecessary trading costs. As the reduced liquidity environment seems persistent, managing the expectations on the client side should be a major contribution to the short term solution.

Swing pricing (2.67)

Fund managers employ swing pricing to prevent dilution and redemption effects in the fund, and to protect current investors. All of the fund managers used a version of swing pricing. A majority of the portfolio managers liked the idea of using the variables "*time, volume and price*" to calculate a swing price. The fund managers emphasized that the use of swing pricing and its calculation should also be operationally viable.

Several interviewees suggested swing factor characteristics. The fund managers identified the absolute size of the volume and the volume relative to the average market issue size to be relevant factors for the swing price. The interviewees also suggested that the swing factor for investments should at least incorporate the bid-ask spread. Asset managers value their funds against the bid side of the market and adding a position crosses the full bid-ask spread. These transaction costs are minimal to protect the dilution effects on the fund. Some portfolio managers even set up a separate transaction account for a client fund or mandate to be able to report on the transaction costs for the incoming money. The portfolio manager supplies a transaction cost target, based on the historic bid-ask spread. Then, the fund manager gathers the trading costs and transitions the securities towards the mandate without affecting the NAV. The fund manager gathers the trading costs and reports them after the transition completes.

Another consideration is the removal of dilution fees and the propagation of this removal in times of fund wide outflows. One of the participants agreed: "*If the market goes down, you would rather say that entering the fund is free."*

Soft closing on funds (1.43)

"It matters if you have a fund of 4 billion versus a fund of 200 million. If I would have a fund of 200 million, I wouldn't worry about liquidity." As one of the participants rightly mentioned, those 4 million positions (2% in the €200 million fund; issuer limit) can be easily sold in the current High Yield corporate bond market. A 2% position in a €4 billion fund equals a total position of €80 million, which is more difficult to sell than €4 million of the same issue. Although fund managers charge fees over the total Assets under Management, soft closing a fund is a prudent measure to protect the existing clients in a fund.

Investment Limits & Diversification (2.13)

The majority of portfolio managers indicated that investment limits are in place when they create a mutual fund strategy or mandate. The predominant diversification method is a percentage based restriction of an issue and of an issuer. Fund managers also take geographical areas and specific sectors into consideration when setting up the investment limits. For example, a portfolio manager who wants to invest in a Spanish utility company due to solid fundamental research might spread the investment over two Spanish based utility companies.

Gating (-2.29)

The subject of gating came up during the interviews as a possibility under the UCITS framework. All of the participants noted that gating is detrimental to your reputation and that gating is prevented at almost all costs, even in stressed periods. The prisoner's dilemma applies, as the dominant strategy is not to apply gating while it might be best for the sector as a whole.

6.6 Evaluation of the interviews

During one of the interviews, the participant indicated that the financial markets had already broadly discussed the fact that liquidity in the credit spectrum deteriorated. The main problem that is left for the financial industry is to find a solution that is operationally viable.

Figure 6.1 shows the classification by top level. The dominant solutions in terms of score are on the individual level, with the exception of the regulatory driven "*queues to exit"*. In the short term, asset managers have to rely on their own liquidity management principles. The industry professionals expect market innovations to catch on in the longer term, but the professionals remain undecided on the timing and which platform becomes market standard. The regulatory guidance on liquidity is problematic, as the liquidity classification demands continuous reviews to be of any use. In terms of one of the participants: *"This type of regulation will only bring on more bureaucratic complexity."*

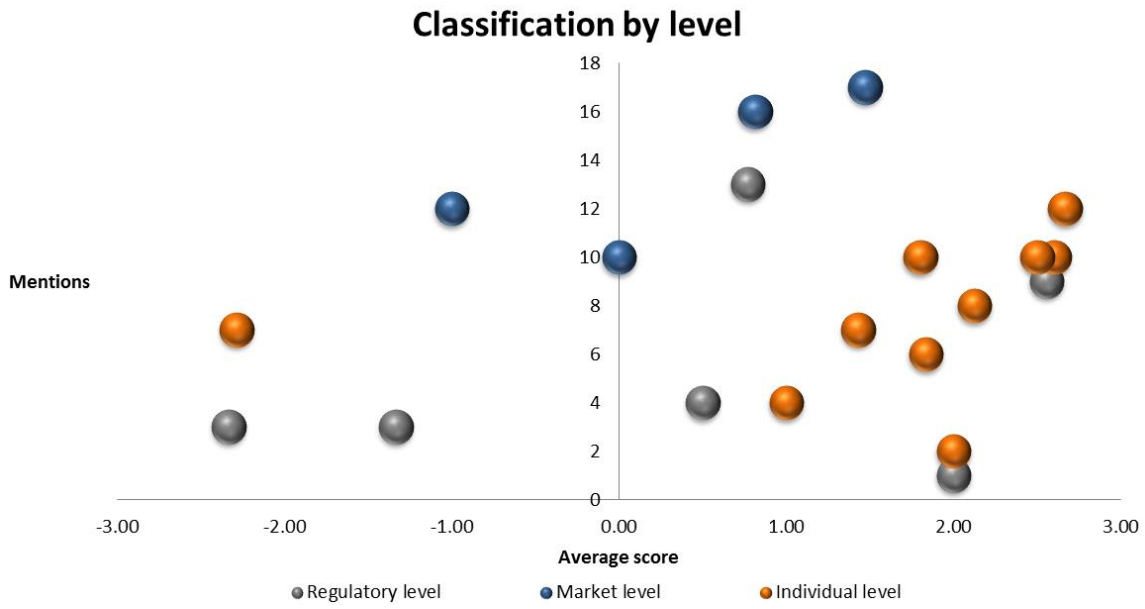

Figure 6.1: Classification by top level (Source: Financial professionals)

On the individual level, mutual fund managers should maintain close contact with end-clients on their plans to either invest or divest in a fund. Sales representatives can stay in close contact with the larger clients. A distribution channel that notifies the mutual fund manager on incoming or outgoing fund flows could benefit the whole portfolio. The portfolio manager then receives the time to liquidate assets over time, an important dimension in identifying liquidity.

The employment of swing pricing is a fair way to protect current clients and to redirect the transaction costs to the end-client who makes those costs. An additional advantage is that swing pricing punishes swift fund movers, as they can be hit with the swing twice in a short period.

On the market level, the financial industry is changing as a result of regulation. The innovators have been announcing the upcoming alternative platforms for a few years already. Whether or not the fund industry will adopt an alternative platform and what the time line for that adoption is, remains unknown.

On a regulatory level, the fund industry as a whole would benefit from obligatory notification periods on the less liquid investment environments.

Lastly, the majority of the participants agreed on the difference between normal period liquidity and liquidity during market stress. An example is the liquidity as perceived during the financial crisis of 2008. This is discussed in more detail in the next chapter.

7. Managing the mismatch

We present guidelines for mutual fund managers to deal with the liquidity mismatch in this section. We propose the guiding principles based on the liquidity environment in Chapters 3 and 4 and the possible scenarios in Chapter 6.

We first look at the theoretical solution for the liquidity mismatch. Then, we present the background for a practical solution. We suggest possible actions during both normal and stressed periods. Finally, we make a proposal for the swing prices and factors of the model portfolios illustrated in Chapters 4 and 5.

7.1 Theory

In theory, every investor owns a share of the fund he invests in. Whether this investment is €1,000.00 or a 4% share of a billion sized fund, everyone holds a cross section of the total investment. Therefore, the fair way to liquidity or invest in a portfolio would be pro-rata. An investor then sells or buys a percentage of the positions in the fund for the money the investor invests or redeems.

The costs associated with buying or selling positions will then be redirected to the person as part of their share of the fund. The transaction costs increase with a smaller time horizon and a larger volume. If we invest a large monetary volume, this results in a higher demand for the specific bonds in the portfolio, increasing the price. The time frame correlates inversely with transaction costs, as a longer time frame to invest or divest the money moves the price closer to the mid-price valuation. With more time, we allow portfolio managers or traders to wait for an opportunity or to find an eligible counterparty without adjusting the price. A graphic representation of these relationships is in Figure 7.1.

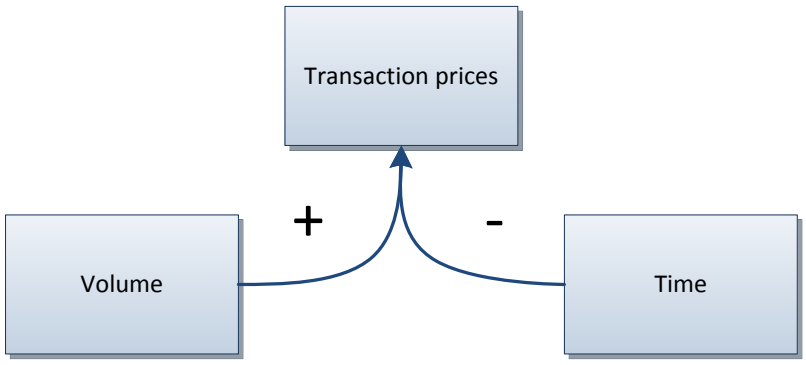

Figure 7.1: Transaction price influences

Business as usual

We described in Section 2.1.2 how every in- and outflow affects fund performance. Theoretically, the cross section owned by the investor needs to be sold when the investor moves out of the fund. The opposite holds if the end-client invests more money in the fund, as a cross section needs to be bought to keep the same risk in the fund. The investor pays the costs for either obtaining the bonds or selling the bonds in the market. The costs for obtaining the bonds can be straightforward, as a fund manager tries to obtain as much bonds as possible with the available inflow to follow the existing strategy.

When the investor wants to move out, the theoretically fair method is to move a cross section of underlying securities from the fund into a transaction account. After selling the securities, the cash in the transaction account flows to the end-clients. The transaction account aggregates all end-clients who move out on a day.

Following the interviews in Chapter 6, we note that a reduction of the volume or an increase of the available times reduces the transaction costs.

Stressed market

In a stressed market, a movement in or out of the fund and the associated transaction costs are also for the end-investor. In the theoretical scenario, we make no difference between a stressed market and business as usual. In a stressed scenario, the redemption of an investor could lose anywhere from 0% of its value up to 99%, depending on the likelihood of a counterparty willing to buy the assets at that point. Even in a stressed scenario, it is possible to liquidate the full portfolio, as promised under the UCITS framework. The discount taken on the NAV ends up with the end-clients and the mutual fund manager can divide cash pro-rata amongst end-clients.

7.2 Reality

The theoretical framework portrays the world as the perfect world, with the possibility to buy and sell every asset whenever it pleases the portfolio manager or trader. In practice, it is impossible to execute redemptions of €1,000.00 split over 100-150 holdings from a general portfolio. It might also be impossible to sell during certain market events, when there is a grid lock and risk appetite is zero.

The rationale for investing in a collective investment vehicle is to obtain exposure to a diversified portfolio. Mutual fund managers collect funds from several types of investors and use the money to execute a certain strategy.

The situation of a fund manager focuses on the fiduciary duty between both their parting and remaining end-clients. The mismatch portrayed throughout this thesis is focusing on how to protect the remaining clients. This protection is vital, as the parting clients in the mutual fund do not receive a pro-rata allocation of the fund. A pro-rata redemption would cancel out the rationale of the investment vehicle. However, paying the parting end-clients with the liquid holdings leaves the remaining clients with a portfolio of less liquid holdings, which potentially sell on a discount when they want to redeem their shares.

In the stressed scenario and the current environment, there is always an investor who can move out first. He receives the NAV of today and the portfolio manager uses the most liquid parts of the fund to do so, i.e. cash, the liquid buckets or the Credit Default Swaps. An end-client that moves out before the fund manager rebalances the portfolio, either during the next day or over the course of the following week, has a worse deal.

The current swing pricing method protects the existing client in a business as usual environment, especially when the market impact and fixed costs of a transaction remain stable. The majority of investors, as taken from the interviews, know to avoid being a forced seller at all cost. At the same time

however, portfolio managers refuse to impose gating on their fund to avoid reputational damage to the asset management company.

7.3 Business as usual propositions

In a "business as usual" scenario in the current low liquidity environment, the three leading suggestions on asset management level from the interviews were: "*Cash", "Swing Pricing"* and "*Contact with end-clients*." The three suggestions should be part of the liquidity management discussion at a mutual fund manager. The portfolio manager who runs a strategy determines the appropriate cash levels, the sales representatives have end-client contact with the notification duty to the portfolio managers regarding fund flows and the swing factor can be used as an investor protection tool.

We suggest two additional methods for a fund manager to deal with the reduced liquidity environment and to protect end-clients. The suggestions are the "*time-model"* and a "*transaction in kind"*.

7.3.1 The time-model

The UCITS fund structure only allows calculating one NAV and one swing calculation for a single fund on a specific day. The UCITS structure increases the difficulty to employ a time component to a mutual fund. If we can stretch the time dimension of a fund flow by choice of the end-client, the decision is beneficial for current, prospective and redeeming investors. The time model assumes a swing pricing method is in place for the fund.

The idea of the time-model is to give an option to the end-client on the time component of his investment. A prospective investor that wants to invest in a mutual fund has the opportunity to choose between a 1 day investment and a 10 day investment.

The 1 day investment period is equal to the current procedure of investing. The investment is either charged by the swing if the net flow of today is positive, or not if the flow is negative.

If the investor chooses to invest over the 10 day horizon, the investor transfers the money into a liquid account managed by the asset management company. The money can then be added to the designated fund by the decree of the portfolio manager. Portfolio managers are aware of the daily fund flows and can therefore remove the costs of transacting. The potential to offset negative and positive fund flows with each other increases.

If the investor opts for the transitional account, the worst-case scenario is a 10 day postponed investment on a long term investment. The best-case scenario is a reduction of transaction costs for both the entering investor and a reduction of market impact for the redeeming investor. The current investor runs less liquidity risk as the fund composition remains unchanged. The decision process can be seen in Figure 7.2.

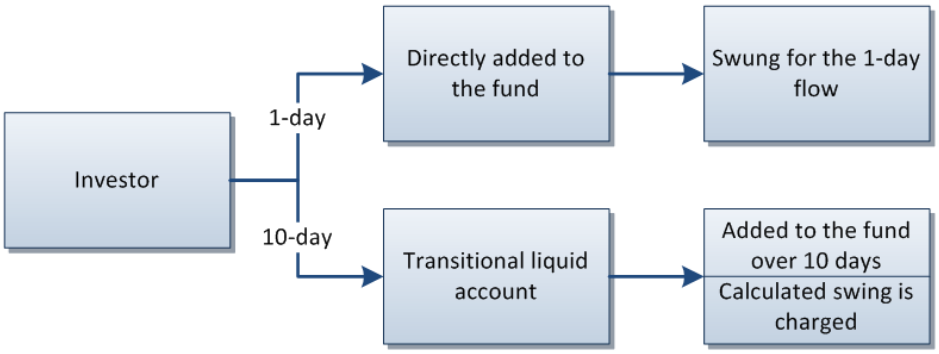

Figure 7.2: The time model

If the fund manager pools the investments in a transitional account, both in- and outflows could be mitigated which reduces effect of flow on the valuation and volatility of the fund's NAV.

Expanding on the time-model

As an additional incentive to an end-investor to choose the 10 –day horizon, we could change the partial swing into a full swing. A full swing removes the threshold level necessary to swing the fund flows. Additionally, an increase in absolute volume of flows should then increase the swing factor. The swing factor increase represents the increased liquidity risks in the fund and the increased transaction costs to redeem or invest for a pro rata section of the portfolio. As this method is cumbersome and might take some time to comprehend, the method is less attractive to implement.

Another expansion on the time-model is to increase the variety of the end-client investment horizon. Instead of only two time horizons, a 5 day horizon and a 14 day horizon could be added. The time-model serves as a voluntary notification period with a reduction of the transaction costs or swing pricing as an incentive for the end-client.

7.3.2 Transaction in kind

The second suggestion we present is the transaction in kind. In a *transaction in kind*, the fund manager pays out the shares of an end-investor in terms of the underlying bonds instead of cash. This measure can be employed for end-investors who want to invest or redeem a substantial percentage and absolute volume of a fund.

The transaction in kind should be given as an option, just like the time-model. Operationally, it takes a while to employ, but it protects all the remaining clients in a portfolio as the clients obtains a cross section of the portfolio. The parting client evades the swing price by using the transaction in kind.

Hypothetically speaking, an absolute boundary to propose the transaction in kind could be €50 million. The threshold is in place as the liquidity risk increases through a higher market impact with larger fund flows. Naturally, the threshold value can be adjusted over time. The flowchart for this measure is in Figure 7.3.

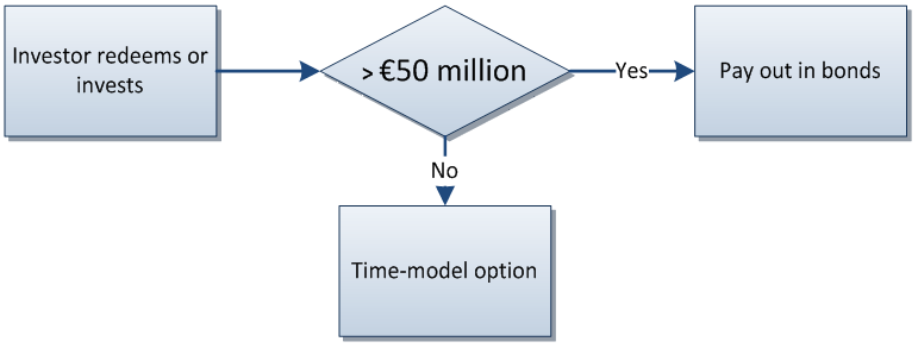

Figure 7.3: Transaction in kind decision process

7.4 Stressed market

The professionals from the financial industry pointed out that the market can go illiquid whenever a credit event occurs. While UCITS allows for gating to be employed, the reputational damage towards the brand of the mutual fund manager is detrimental.

A possible solution follows the decision process we show in Figure 7.1. As the market characterizes a stressed period by continuous outflows and possible discounts, the real transaction costs would be higher than the employed swing price during this period. The normal swing price that is in place during these stressed periods should therefore be discarded and a variable swing price that represents the full costs of selling a pro rata section of the portfolio should be incorporated. A transition account as we propose in the theoretical situation could be used as outflow method. The cross section of the holdings for the redeeming end-clients will be sold through that separate account, removing the liquidity impact on the original fund and other investors. The graphical representation of this decision process can be found in Figure 7.4.

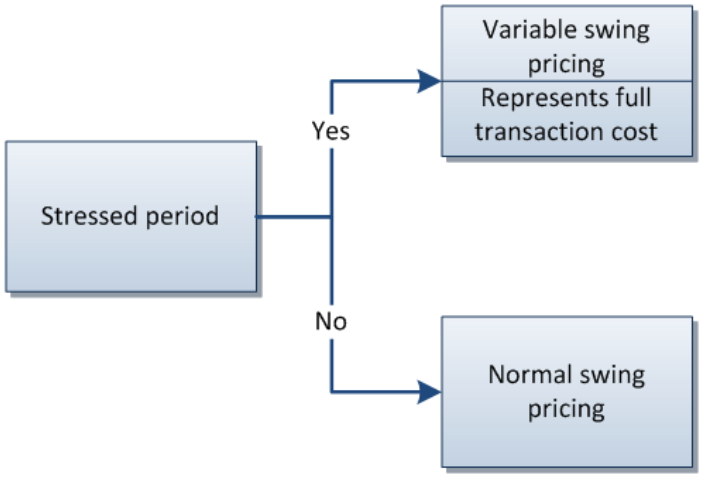

Figure 7.4: Variable swing pricing

The variable swing price could also be a mark-up on the standard swing price. For example, the increased volatility and reduction of market depth scenarios in Section 4.2.3 show a transaction cost

increase of 20%-30% when we compare the 1-day market liquidation component. Therefore, the initial swing price factor increase could be around 30%, depending on the developments in the market.

A credit event might instigate the stressed period. Otherwise, large outflows can be transitioned either in kind or through the normal swing. Ex post, the portfolio manager rebalances the fund. The risk on a credit event, which occurs during the rebalancing of a portfolio that had a substantial outflow, remains.

The benefit of using the severe variable transaction costs is that the remaining investors will not pay for the investors who want to move out. Under no circumstance would it be fair to allocate the costs made by the redeeming investor to the remaining clients which are under the fiduciary duty of the portfolio manager. The mark up on the existing swing factor is operationally more viable.

7.5 The individual asset manager

The various financial professionals advised during the interviews to make use of a swing factor, to hold close contact with the end-clients and to prevent a fire-sale at all costs by keeping enough cash and other liquid assets. We first show the various parameters that can indicate liquidity. Then, we propose an operationally viable method to determine a swing factor for the model portfolios we present in Chapters 4 and 5. The swing factor can be used together with our suggestions in Sections 7.3.1, 7.3.2 and 7.4.

7.5.1 Swing parameters

The swing factor should represent the costs to liquidate or to invest a cross section of the portfolio for respectively a redeeming or investing client. From the literature in Section 3.2 and 3.2.1, the description of market practices by sell-side researchers in Section 3.4 and the conducted interviews, we can take several liquidity parameters into account. We combine these parameters in Table 7.1.

	Literature	Market practices	Interviews
Market			
Market volatility	x	x	x
Relative trading volume to market size	x		x
Average issue size in market		x	x
Fund size with respect to market			x
Trade flows			
Trade Volume	x	x	x
Time		x	x
Issue characteristics			
Age	x	x	x
Time to maturity	x	x	x
Bid-ask Spread	x	x	x
Issue size / Amount outstanding		x	x
Issuer size			x
Duration times Spread		x	x
Daily forecasted trading volume		x	x

Table 7.1: Liquidity parameters (Source: Literature, market practices & interviews)

The liquidity parameters in Table 7.1 give a liquidity indication. However, it remains difficult to incorporate these numbers into a forecasting value for corporate bonds that actually trade and the bonds that do not. Therefore, we look into an operationally viable benchmark to measure the swing price.

An implementation of all the variables into a single liquidity measure with the limited trading data available at a mutual fund manager would be a cumbersome method to determine the swing factor. As an operationally viable method, we assess the forecasted transaction costs for the model portfolios from Chapter 4 and 5. We present the market practices for the three model portfolio as of 09-30-2015. The LCS represents the Liquidity Cost Score by Barclays, Aladdin is the Transaction Cost model and the BVAL RTC is the Round Trip Cost method for the bid-ask quotes from Bloomberg.

Figure 7.5: Liquidation costs in basis points (Source: Barclays, Aladdin, Bloomberg)

Figure 7.6: Investment costs in basis points (Source: Barclays, Aladdin, Bloomberg)

In Figure 7.5 we omit the LCS and BVAL costs. The model portfolios have a bid side valuation, so we can only incorporate the market impact component. Aladdin provides a market impact model for the transaction costs when liquidating a portfolio, Barclays and Bloomberg do not. If we are to invest in a fund, we have to cross the full bid-ask spread. The three market practices calculate the bid-ask spread, but again omit the market impact component.

7.5.2 Swing proposals

The swing factor should represent the transaction costs that a redeeming or entering investor makes. Especially in the case of investments, both the LCS and the BVAL provide the same methodology and rationale. A proprietary measure that calculates the internal trading costs as a percentage of the bid valuation could be added to the spectrum.

Euro Investment Grade

The first part of the Euro Investment Grade proposal is to apply a full swing. The full swing mitigates the risk that an end-client knows the threshold level and avoids the threshold by making smaller deposits. Next to that, it is fair to charge all investors for the dilution as the full bid-ask spread has to be paid.

For the swing factor itself, we take an average of the LCS from Barclays and the BVAL RTC for the investment costs. Determining the liquidation cost is difficult as the market impact and liquidity risk are hard to quantify. We consider the pro-rata market impact from Appendix E and the liquidity parameters from Table 7.1 to pinpoint a reasonable cost for both the market impact and the liquidity risk.

The proposed swing factors for the Euro Investment Grade fund based on the September 2015 data are therefore:

Investment costs @ subscriptions: x

Liquidation costs @ redemptions: x

European and Global High Yield

Consistent with the Euro Investment Grade proposal, both the European and Global High Yield should apply a full swing instead of a partial swing to fund flows.

We follow the same rationale that the round trip costs provide a good indication of the investment costs. For both the European and the Global High Yield funds, we take an average of the LCS and the BVAL RTC.

The market impact and liquidity risks when we liquidate a portion of the portfolio is challenging to quantify. In Appendix E, we observe the pro-rata liquidation cost on a 1-day horizon to be around **x** basispoints for 25% of the European High Yield fund and around **x** basispoints for 25% of the Global High Yield fund. However, from our interviews we know that trading in the High Yield market will likely move the price quite easily. Again, the swing factor should represent the transaction costs that a redeeming investor makes and should compensate the remaining investors for the liquidity risk they run. We use the information from the pro-rata liquidation, the interviews and the liquidity parameters to pinpoint a reasonable cost for both the market impact and liquidity risk of the High Yield funds.

The proposed swing factors for the European High Yield fund based on the September 2015 data are:

Investment costs @ subscriptions: x

Liquidation costs @ redemptions: x

The proposed swing factors for the Global High Yield fund based on the September 2015 data are:

Investment costs @ subscriptions: x

Liquidation costs @ redemptions: x

Expanding on the swing factor

Both fund flows and the swing price calculation occur daily. Therefore, we omit the time dimension from our initial swing price calculation. If regulation would allow several NAV calculations for the same fund, mutual fund managers can implement a time component in the swing factor. This translates into a discount on the swing price to investors who are timely in notifying the mutual fund manager and allow them to anticipate future fund flows.

As we mentioned, the current UCITS structure allows for only one NAV calculation per day for all end-clients. If individual end-clients could be charged, it would be interesting to incorporate a volume-based model. In the volume-based model, the swing factor depends on the level of absolute cash flow. A large investment or redemption takes more time and has a large effect on the strategy. For example, a 10 million redemption is easier to facilitate than a 50 million redemption. From our interviews and the Transaction model from Aladdin, Figure 3.5, we take that the market impact component increases with more absolute volume. This should result in higher costs than only 5 times the 10 million swing price for the 50 million redemption.

In the stress scenario, the swing factors could be increased by 50% as a first line of defense if the variable swing price is operationally unachievable.

7.6 On managing the mismatch

The focus of an asset manager in the liquidity mismatch is on his own actions. The individual actions are the short-term solution to remedy the situation. Contact with end-clients on possible flows and knowledge of the liquidity problems in the market are the top priority for the mutual fund manager. Portfolio managers know that rebalancing in the current market can take up to several days and are adjusting to this new information and status quo.

To protect the existing clients from dilution and liquidation risks, the incorporation of a swing factor seems a logical second step. This swing factor consists of both the costs of transacting, as well as the costs of the exposure to liquidity risks during the rebalancing of the portfolio. Especially the second part is difficult to measure, as a daily forward looking assessment of the various liquidity dimensions are part of this analysis.

8. Conclusion and further research

In this paper we present an analysis on the liquidity in the corporate bond market in both Europe and the United States. After the liquidity analysis, we continue with an investigation into the set of possible actions at the disposal of an asset manager, and evaluate the direction the credit market is heading into.

We perform the analysis of the liquidity environment by breaking down TRACE data with liquidity proxies, a description of the current and proposed regulatory guidelines, and a review of the applied liquidity measures available from the sell-side platforms. We complete the analysis with an assessment of the possible risks an asset manager runs in a portfolio using the Value at Risk approach and an extension which incorporates liquidity.

The research on handling the mismatch included 18 interviews with in total 20 financial professionals. During these interviews, the regulatory, market and asset management perspective were subject of the scrutiny. The results of the consultation have been presented in a classification overview in Table 6.1.

The two sections together create the framework to answer the main research question of this paper:

> *"How should mutual fund managers and regulators deal with the mismatch between the liquidity offered by UCITS and the underlying liquidity environment, in both the secondary market of European and American corporate bonds?"*

In the following sections we discuss the findings and wrap up with suggestions for future research.

8.1 Conclusions

The puzzle on the mismatch between the liquidity environment in European and American corporate bonds on the one hand, and the redemption possibilities for end investors other hand is a complicated one.

The puzzle involves dimensions such as immediacy, depth, breadth and resilience, resulting in transaction costs for the investor moving in or out of the fund, and investment risks for the remaining investors. When an investor moves in, the market exposure dilutes. These opportunity costs can be compensated by charging the transaction costs together with the market impact component. When an investor moves out, the redemption results in a less liquid composition of the portfolio. The mutual fund manager pays the redeeming investor with liquid assets and rebalances the portfolio over time. The liquidity risk and the exposure time to the liquidity risk are both hard to quantify.

Underlying liquidity

The IMF proposes four dimensions of liquidity, represented by *breadth*, *depth*, *immediacy* and *resilience*. Academics contribute to the liquidity discussion by searching for proxies that analyze the characteristics of liquid and illiquid bonds. Academics test the majority of these proxies on the more liquid part of the corporate bond environment as they use actual trade data for their studies and half of the corporate bonds do not even trade once during a month. Figure 4.4 shows the percentage of bonds that do not trade.

The supervisory bodies acknowledge the liquidity mismatch, but have so far been unable to provide beneficial guidelines for mutual fund managers.

The market practices from the sell-side researchers give a broad spectrum of variables that can account for liquidity. The rationale of computing a round-trip trade in the market in the Liquidity Cost Score from Barclays is sound, although the quotes based measure lacks a time component and a realization of the costs. The Transaction Cost model of Aladdin adds the time component and shows how it affects expected transaction costs. However, the actual transaction costs reported to liquidate a full portfolio in terms of market impact is low and seems improbable. The calculation for the transaction model is opaque, as BlackRock adjusts the model with in-house data. The Bloomberg BVAL score is too broad as a liquidity measure, as the BVAL perceives most securities as liquid. The BVAL Bid-Ask spread focuses on the portfolio positions and makes it possible to calculate the round trip measure for current holdings against quoted prices, showing similarities with the LCS.

The main point from the interviews and market updates on liquidity is that corporate bond liquidity deteriorated along the dimensions of depth, immediacy and resilience. Regulatory transparency affects the quoted bid-ask spreads in the market.

Managing the mismatch

We discussed a wide variety of suggestions for mutual fund managers, the market and supervisors during the interviews. While the individual level proposals cover the short term, a consolidated buy-side plan is necessary.

The consolidated buy-side plan could be to collectively suggest notification periods for specific funds to the regulator. The buy-side plan could also be determining which e-trading platforms to use, exponentially increasing the possible trade connections through either dark pools or matching algorithms. Even in creating the all-to-all platform or connecting to the inter-dealer broker market, collective action is required.

End-client contact and matching the inflows and outflows in a mutual fund over a longer period could benefit both the fund and the end-clients. The portfolio manager can use the time to maneuver the reduced liquidity environment of the corporate bond market and adjust the strategy accordingly.

In a stressed environment, a pro-active attitude in consoling end-clients is of utmost importance. Fixed income investments in general should focus on a longer horizon. If an end-client wants to redeem during volatile times, he pays for it pro-rata. The transaction costs and market impact of the redemption is then for the parting investor, protecting the current client.

8.2 Further research

The exploration of the corporate bond market during this study was intriguing. With an over-the-counter nature, numerous traits for fixed income securities and the lack of transparency for the European market, it feels like the wild west of the asset world. Portfolio managers and fundamental analysis add value, in a market driven by a limited number of market-makers and investors.

We researched the liquidity component of corporate bonds. The analysis we perform involves TRACE data and therefore account only for the more liquid part of the corporate bond space. A further investigation into the less traded spectrum of the corporate bond market would be intriguing. A possible methodology would be to use aggregate data from several mutual fund managers and use that data to calculate the implied liquidity measure by Bushman, *et al.* (2010), or the latent liquidity from Mahanti, *et al.* (2008).

The consensus in the market, as taken from the interviews, suggests that a loosening of the regulation is welcome. A research into the consequences of loosening regulation in order to bring back market-makers as the oil of the over-the-counter market seems challenging and thought provoking.

A third suggestion is to analyze the effects on end-client behavior if we redirect the full pro-rata market impact and transaction costs on to the redeeming end-client in a stress scenario. Would the end-client change his decision to redeem his investments if he knows the costs to do so are high? We recommend behavioral concepts such as prospect theory, and splitting off in cooperative games subjects for further research.

Finally, further research on the swing factor benefits the robustness and trustworthiness of the swing factor. An analysis that incorporates a longer time horizon and internal trading data could serve as the basis for the swing factor model. As a basis for the internal data, the mutual fund manager could take the valuation of a security at the decision moment and at the moment when the order fulfills. The round trip cost could give further insight in the market impact.

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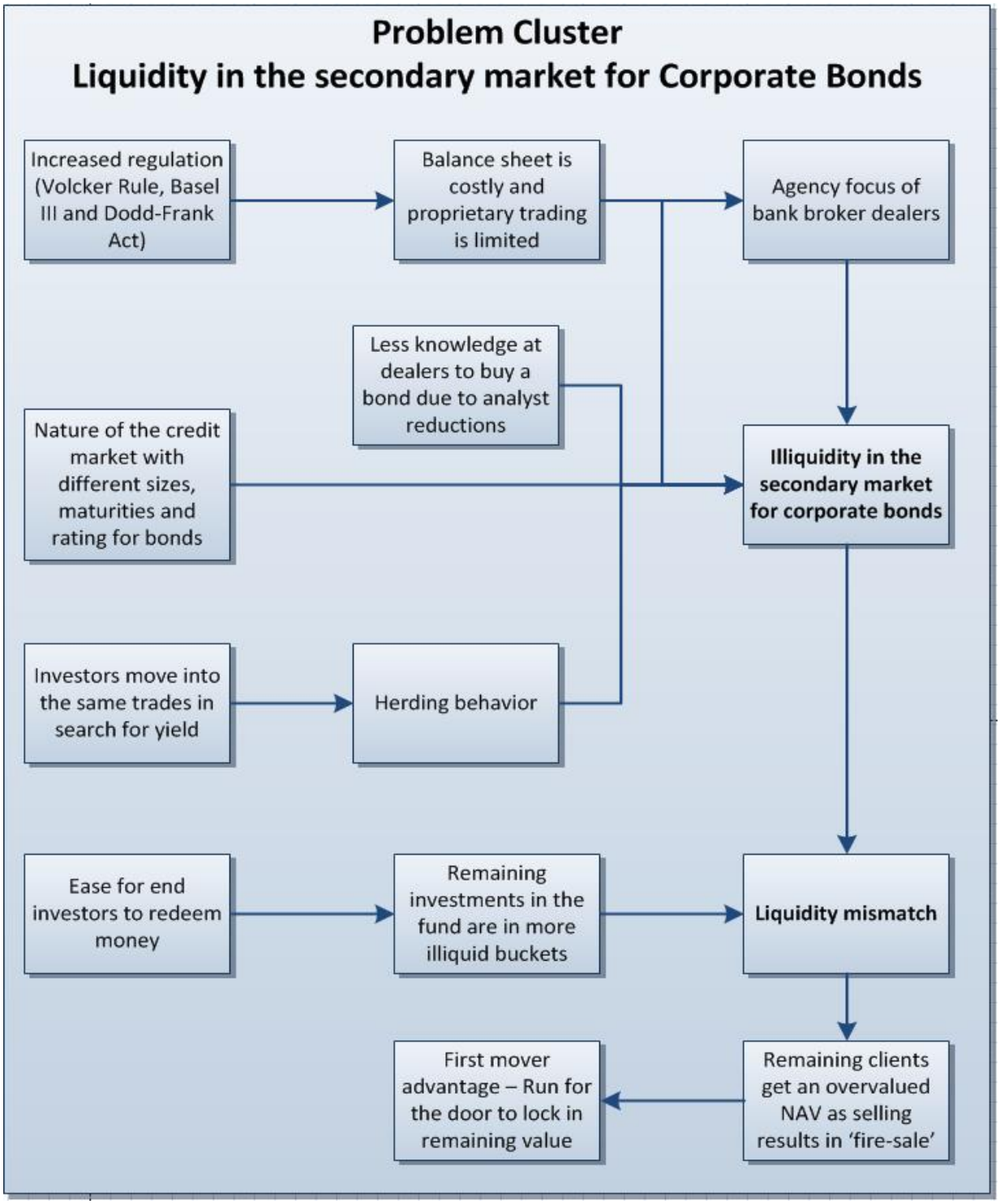
Appendices

Appendix A – Problem Cluster



Appendix B – Average Trade Volume European and American bonds

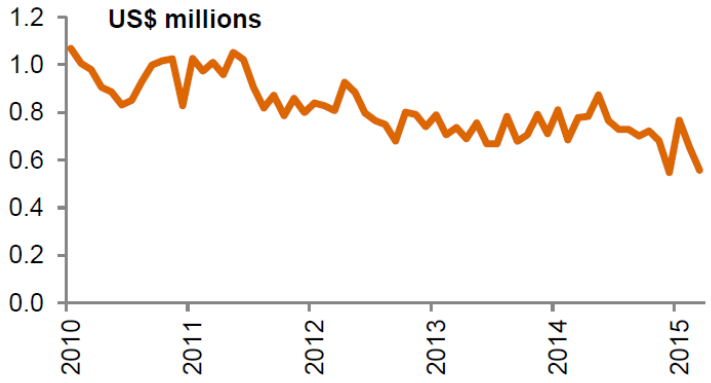


Figure B1: European Corporate Bonds, average trade size (Source: PWC Report, Trax)

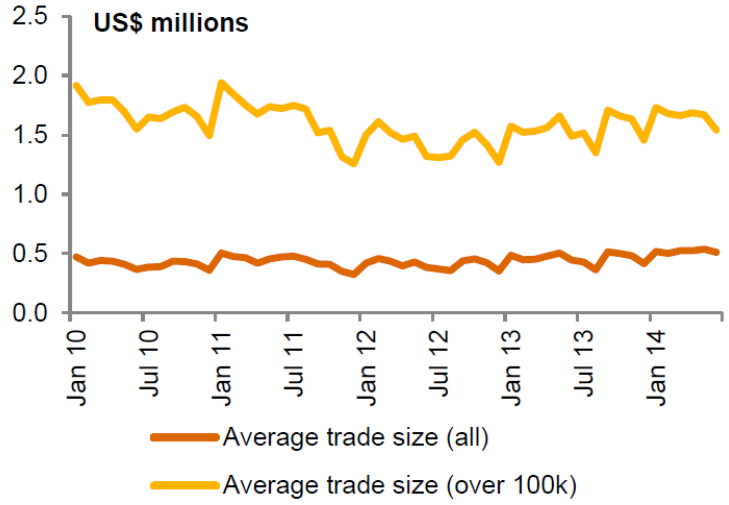


Figure B2: US Investment Grade bonds, average trade size (Source: PWC Report, MarketAxess)

Appendix C – Programming Code

```
# Set working directory to where csv file is located
setwd("C:/LocalData/CSV_R/Enh_Trace_10")

# Install packages
install.packages("plyr")
install.packages("zoo")
install.packages("data.table")
install.packages("sqldf")
install.packages("stringr")
install.packages("RODBC")
install.packages("ggplot2")
install.packages("RMySQL")
install.packages("lubridate")
install.packages("qcc")
install.packages("dplyr")

# Take in use packages
library("plyr")
library("zoo")
library("data.table")
library("sqldf")
library("stringr")
library("RODBC")
library("ggplot2")
library("RMySQL")
library("lubridate")
library("qcc")
library("dplyr")

# combining all trade .csv files for the period 2007Q3 - 2012Q4 into 1
data table

#Get the files names
file_list = list.files(pattern=".csv")

#first apply read.csv, then rbind
myfulldata<- rbindlist(lapply(file_list,fread))

#List the variables
names(myfulldata)
#Summarize total data set
summary(myfulldata)

# Windsorizing the data


##Erasing cancellations from the full dataset & erasing volumes lower
than 100.000 from dataset
institutionaldata<- subset(myfulldata, ENTRD_VOL_QT>=100000 & TRC_ST ==
"T")
# order the data to have a chronological sequence
institutionaldata[order(institutionaldata$CUSIP_ID,
institutionaldata$TRD_EXCTN_DT, institutionaldata$TRD_EXCTN_TM)]
summary(institutionaldata)

```

```
52
53 # Clear memory for further calculations
54 rm(myfulldata)
55 gc()
56
57
58 #institutionaldata is in the format %dd/%mm/%YYYY
59 write.csv((institutionaldata),"C:/LocalData/Enh_Trace_10/Results/institutionaldata.csv")
60
61 #Data table created
62 DT <- data.table(institutionaldata)
63
64
65 #Final list of bond names
66 write.csv(unique(institutionaldata$BOND_SYM_ID),"C:/LocalData/CSV_R/Enh_Trace_10/Results/UniqueBondSymbols.csv")
67 #Final list of CUSIP names
68 write.csv(unique(institutionaldata$CUSIP_ID),"C:/LocalData/CSV_R/Enh_Trace_10/Results/CUSIP_list.csv")
69
70
71 # TURNOVER RATIO - TOTAL TRADING VOLUME/AMOUNT OUTSTANDING
72 #--------------------------------------
73 # Trade volume per Cusip name for a specific month
74 dt3<- data.table(institutionaldata, key = "CUSIP_ID,TRD_EXCTN_DT")
75 CusipMnthTradeVolume<- dt3[, TRD_EXCTN_DT :=
   as.yearmon(TRD_EXCTN_DT,"%d/%m/%Y")][, list(sum = sum(ENTRD_VOL_QT)),
   by="CUSIP_ID,TRD_EXCTN_DT"][order(CUSIP_ID)]
76 write.csv((CusipMnthTradeVolume),
   "C:/LocalData/Enh_Trace_10/Results/CusipMnthTradeVolume.csv")
77
78
79 # ZERO TRADING DAYS - TRADED DAYS / ALL TRADING DAYS IN A MONTH
80 #--------------------------------------
81 #
82 TradeDays_Month<- table(dt3$CUSIP_ID,dt3$TRD_EXCTN_DT)
83 write.csv((TradeDays_Month),
   "C:/LocalData/CSV_R/Enh_Trace_10/Results/TradeDays_Month.csv")
84
85 ConversionDatesData<- institutionaldata
86 ConversionDatesData$TRD_EXCTN_DT<-
   as.POSIXct(ConversionDatesData$TRD_EXCTN_DT, format="%d/%m/%Y")
87 ConversionDatesData$US_TRD_EXCTN_DT<-
   format(ConversionDatesData$TRD_EXCTN_DT, format="%m/%d/%Y")
88 UniqueTradeDaysMonth<- table(ConversionDatesData$CUSIP_ID,
   ConversionDatesData$US_TRD_EXCTN_DT)
89 write.csv((UniqueTradeDaysMonth),
   "C:/LocalData/CSV_R/Enh_Trace_10/Results/UniqueTradeDaysMonth.csv")
90 #--------------------------------------
91 #
92 #Clear memory for Amihud measure
93 rm(ConversionDatesData)
94 rm(CusipMnthTradeVolume)
95 rm(dt3)
96 rm(TradeDays_Month)
97 rm(UniqueTradeDaysMonth)
```

```
98 gc()
99
100
101       # Amihud Illiquidity?
102       h<- 0
103       g<- 0
104       dtotal_j<- 0
105       my.list <- vector("list", nrow(institutionaldata))
106       for (i in 1:length(institutionaldata$CUSIP_ID)){
107         if (institutionaldata$CUSIP_ID[i] ==
   institutionaldata$CUSIP_ID[i+1] & institutionaldata$TRD_EXCTN_DT[i] ==
   institutionaldata$TRD_EXCTN_DT[i+1]){
108           g= (abs((institutionaldata$RPTD_PR[i+1]-
   institutionaldata$RPTD_PR[i])/institutionaldata$RPTD_PR[i])/(institutio
   naldata$ENTRD_VOL_QT[i+1]/1000000))
109           h=(c(institutionaldata$CUSIP_ID[i+1],
   institutionaldata$TRD_EXCTN_DT[i+1], g))
110           my.list[[i]]= h
111         }
112       }
113       dtotal_j<- rbind(dtotal_j, do.call(rbind, my.list))
114
115
116       # Transform to quarterly based data
117       dt_jQ1<- data.table(dtotal_j)
118       Numeric_dates <- data.table(dtotal_j,
   as.numeric(as.POSIXct(dt_jQ1$V2, format = "%d/%m/%Y")))
119       Numeric_dates <- Numeric_dates[, c("V1", "V3") := NULL]
120       Numeric_dates <- Numeric_dates[, V2 := NULL]
121       setnames(Numeric_dates, "V2", "DateInNumber")
122
123
124       # The table is reduced to 1 row, then the name is changed, as the
   column numbers proved to be quite difficult to change (identical names
   allowed in Data.table structure)
125
126       Anothertry <- data.table(cbind(dt_jQ1, Numeric_dates))
127       dt_jQ2<- subset(Anothertry, Anothertry$DateInNumber <
   as.numeric(as.POSIXct("01/04/2010", format="%d/%m/%Y")))
128       dt_jQ3<- subset(Anothertry, (Anothertry$DateInNumber >
   as.numeric(as.POSIXct("31/03/2010", format="%d/%m/%Y")) &
   Anothertry$DateInNumber < as.numeric(as.POSIXct("01/07/2010",
   format="%d/%m/%Y"))))
129       dt_jQ4<- subset(Anothertry, (Anothertry$DateInNumber >
   as.numeric(as.POSIXct("30/06/2010", format="%d/%m/%Y")) &
   Anothertry$DateInNumber < as.numeric(as.POSIXct("01/10/2010",
   format="%d/%m/%Y"))))
130       dt_jQ5<- subset(Anothertry, (Anothertry$DateInNumber >
   as.numeric(as.POSIXct("30/09/2010", format="%d/%m/%Y")) &
   Anothertry$DateInNumber <= as.numeric(as.POSIXct("31/12/2010",
   format="%d/%m/%Y"))))
131       write.csv((dt_jQ2),
   "C:/LocalData/CSV_R/Enh_Trace_10/Results/dt_jQ1.csv")
132       write.csv((dt_jQ3),
   "C:/LocalData/CSV_R/Enh_Trace_10/Results/dt_jQ2.csv")
133       write.csv((dt_jQ4),
   "C:/LocalData/CSV_R/Enh_Trace_10/Results/dt_jQ3.csv")
```

```
134       write.csv((dt_jQ5),
   "C:/LocalData/CSV_R/Enh_Trace_10/Results/dt_jQ4.csv")
135
136
137       # Clear total memory of all variables. Use when new
138       rm(dt_jQ1)
139       rm(dt_jQ2)
140       rm(dt_jQ3)
141       rm(dt_jQ4)
142       rm(dt_jQ5)
143       rm(Anothertry)
144       rm(Numeric_dates)
145       rm(dtotal_j)
146       rm(my.list)
147       rm(file_list)
148       rm(institutionaldata)
149       gc()
150
151
152       #ROUND TRIP COST (RTC)
153       #-------------------------------------
154       #Data set
155       RoundTripData<- institutionaldata[, list(CUSIP_ID, TRD_EXCTN_DT,
   TRD_EXCTN_TM, RPTD_PR, ENTRD_VOL_QT,
   RPT_SIDE_CD)][order(institutionaldata$CUSIP_ID,
   institutionaldata$TRD_EXCTN_DT, institutionaldata$TRD_EXCTN_TM)]
156       #Formula
157       k<-0
158       g<-0
159       totalRTC<- 0
160       my.list2 <- vector("list", nrow(RoundTripData))
161       for (i in 1:length(RoundTripData$CUSIP_ID)){
162         if (RoundTripData$CUSIP_ID[i] == RoundTripData$CUSIP_ID[i+1] &
   RoundTripData$TRD_EXCTN_DT[i] == RoundTripData$TRD_EXCTN_DT[i+1] &
   RoundTripData$ENTRD_VOL_QT[i] == RoundTripData$ENTRD_VOL_QT[i+1]){
163           if (RoundTripData$RPT_SIDE_CD[i] == "B" &
   RoundTripData$RPT_SIDE_CD[i+1] == "S"){
164             g= ((RoundTripData$RPTD_PR[i+1]-
   RoundTripData$RPTD_PR[i])/RoundTripData$RPTD_PR[i])
165             k= (c(RoundTripData$CUSIP_ID[i+1],
   RoundTripData$TRD_EXCTN_DT[i+1], g))
166             my.list2[[i]]= k}
167         }
168       }
169       totalRTC<- rbind(totalRTC, do.call(rbind, my.list2))
170
171       h<-0
172       j<-0
173       totalRTC2<- 0
174       my.list3 <- vector("list", nrow(RoundTripData))
175       for (i in 1:length(RoundTripData$CUSIP_ID)){
176         if (RoundTripData$CUSIP_ID[i] == RoundTripData$CUSIP_ID[i+1] &
   RoundTripData$TRD_EXCTN_DT[i] == RoundTripData$TRD_EXCTN_DT[i+1] &
   RoundTripData$ENTRD_VOL_QT[i] == RoundTripData$ENTRD_VOL_QT[i+1]){
177           if (RoundTripData$RPT_SIDE_CD[i] == "S" &
   RoundTripData$RPT_SIDE_CD[i+1] == "B"){
```

```
178             h= ((RoundTripData$RPTD_PR[i]-
   RoundTripData$RPTD_PR[i+1])/RoundTripData$RPTD_PR[i+1])
179             j= (c(RoundTripData$CUSIP_ID[i+1],
   RoundTripData$TRD_EXCTN_DT[i+1], h))
180             my.list3[[i]]= j}
181           }
182         }
183         totalRTC2<- rbind(totalRTC2, do.call(rbind, my.list3))
184
185         write.csv((totalRTC),
   "C:/LocalData/CSV_R/Enh_Trace_10/Results/totalRTC1.csv")
186         write.csv((totalRTC2),
   "C:/LocalData/CSV_R/Enh_Trace_10/Results/totalRTC2.csv")
187
188         rm(Feldhutter)
189         rm(totalRTC)
190         rm(totalRTC2)
191         rm(RoundTripData)
192         rm(g,h,i,j,k)
193         rm(my.list2)
194         rm(my.list3)
195         rm(institutionaldata)
196         rm(file_list)
197         gc()
```

Appendix D – LCS Age Buckets

European High Yield

Figure D1: European High Yield % of the PF in an age bucket

Figure D2: European High Yield – average LCS per Age buckets

Global High Yield

Figure D3: Global High Yield % of the PF in an age bucket

Figure D4: Global High Yield - average LCS per Age buckets

Euro Investment Grade

Figure D5: Euro Investment Grade % of the PF in an age bucket

Figure D6: Euro Investment Grade - average LCS per Age buckets

Appendix E – Aladdin Pro-Rata Liquidation Costs

European High Yield

Figure E1: Pro-rata market impact - Liquidation cost

Figure E2: Pro-rata market impact - Investment cost

Global High Yield

Figure E3: Pro-rata market impact - Liquidation cost

Figure E4: Pro-rata market impact – Investment Cost

Euro Investment Grade

Figure E5: Pro-rata market impact – Liquidation Cost

Figure E6: Pro-rata market impact – Investment Cost

Appendix F – LCS – Value at Risk

LCS – VaR Portfolio Global High Yield (7/31/15)

Table F1: Liquidation Costs Global High Yield (Source: Aladdin)

Figure F1: LCS- VaR in the Global High Yield Model portfolio (Source: Barclays, Aladdin)

Figure F2: Comparison of two months LCS for the Global High Yield (Source: Barclays)

LCS – VaR Portfolio European High Yield (7/31/15)

Table F2: Liquidation Costs from the Aladdin overview

Figure F3: LCS- VaR in the European High Yield Model portfolio (Source: Barclays, Aladdin)

Figure F4: Comparison of two months LCS for the Global High Yield (Source: Barclays)

Appendix G – Guiding interview questions

Introduction:

How has the European corporate bond market changed over the past 2-5 years? How 'broken' is the market compared to these years?

Liquidity

What is liquidity according to you? What would you want to know about it and to what end?

How do you currently measure liquidity? Is there anything you find difficult in measuring liquidity?

How do you perceive market updates around liquidity such as the Liquidity Cost Score by Barclays or the BVAL from Bloomberg?

How do you see the role of market makers? Capital Risk or agency risks?

If pm: ***Do you see dealers "work" more orders?***

If trader: ***Do you try to keep smaller books? How are you personally managing your risk?***

Do you see a liquidity mismatch arise between UCITS funds and the underlying securities? *To quote Howard Marks: no investment vehicle should promises greater liquidity than is afforded by its underlying assets.*

If pm: ***How are you as an investor handling outflows or inflows in a fund?*** *Ideas on optimal portfolio management?*

How should this liquidity mismatch be handled according to you?

Regulation

In your view, what reforms do you think are needed with regard to regulation on the corporate bond market?

In your view, what would be the potential effect on liquidity of increasing regulation (MiFID II with Transparency rules for Europe, effects of TRACE in the US)?

How do you see your fiduciary duty towards your clients to treat them all in the same manner? How do you achieve this?

Innovations and standardization

What type of innovations could help the market to deal with liquidity in your view?

What do you think about standardization of corporate bonds? How much of a viable option is that?

Appendix H – Proposition overview