ROBECO
The Investment Engineers

Liquidity risk management for investment funds: towards an effective framework

White paper

For professional investors
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‘Liquidity risk is one of the key financial risks faced by open-ended investment funds’

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Executive summary

To be considered effective, a liquidity risk management framework should prevent and mitigate episodic and incremental liquidity risk. Measuring, monitoring and mitigating liquidity risk are key parts of the liquidity risk management framework. In our approach, monitoring liquidity risk comes down to one formula: *liquidity supply minus liquidity demand equals the liquidity surplus or shortfall*. MSCI's LiquidityMetrics can play a key role in liquidity risk monitoring. This framework meets the requirements under the current version of UCITS and AIFMD regulations and takes IOSCO recommendations into account.

Liquidity risk is one of the key financial risks faced by open-ended investment funds. Nevertheless, we have yet to come across any comprehensive descriptions of an effective liquidity risk management framework in the literature. This paper aims to provide a thorough understanding of the components required in order to build an effective liquidity risk management framework and how MSCI's LiquidityMetrics can play a role in this.

A discussion about liquidity risk management frameworks should begin with a definition as to exactly what liquidity risk is. We differentiate between episodic liquidity risk and incremental liquidity risk. Episodic liquidity risk is the risk that assets cannot be sold in a timely and cost-efficient manner in order to meet funding obligations. Incremental liquidity risk is the risk of investor dilution as a result of subscriptions and redemptions in a fund as these transactions lead to transaction costs for the fund.

To be deemed effective, a liquidity risk management framework should prevent and mitigate episodic and incremental liquidity risk. Ex-ante liquidity risk management tools help prevent the liquidity risk from arising. Should liquidity risk occur, ex-post liquidity risk management tools mitigate its impact.

'A discussion about liquidity risk management frameworks should begin with a definition as to exactly what liqidity risk is'

Robeco's framework

Measuring and monitoring liquidity risk is a key part of the liquidity risk management framework. In our approach, liquidity risk monitoring comes down to a simple formula: *liquidity supply minus liquidity demand equals the liquidity surplus or shortfall.*

To determine the liquidity supply, we use MSCI's LiquidityMetrics, which builds on the premise that asset liquidity is best understood as three-dimensional. In our framework, we calculate asset liquidity differently for equities and fixed income, taking into account the characteristics of the markets in which the two asset classes are traded. In addition to the 'regular' asset liquidity calculations, it is important to consider the liquidity conditions of a fund in stressed environments. For this purpose, asset liquidity stress testing is performed.

Liquidity demand is determined with two different approaches: historical redemption scenarios and hypothetical redemption scenarios. The historical redemption scenarios are based on the historical redemptions of a fund. The hypothetical redemption scenarios are based on the current client composition of a fund, assuming a certain run-off factor. Furthermore, the liquidity demand as a result of variation margin on derivatives is taken into account.

The liquidity supply of a fund minus the liquidity demand equals the liquidity surplus or shortfall. Four situations are monitored based on the combination of the different calculations of liquidity supply and liquidity demand. The results of the four scenarios lead to a portfolio liquidity risk severity score ranging over five classes from zero to very high.

In our opinion, this liquidity risk management framework is complete, parsimonious and easy to understand. As such, it is effective. Furthermore, it meets the requirements under the current version of UCITS and AIFMD regulations and takes IOSCO recommendations into account.

Introduction

Liquidity risk is one of the key financial risks for open-ended investment funds. It is a much-debated topic by academics, the asset management industry and regulators, alike. Nevertheless, we have yet to come across any comprehensive descriptions of an effective liquidity risk management framework in the literature. This paper aims to fill that gap.

Before proposing a liquidity risk management framework, we must first define what is meant by 'liquidity risk'. In our definition, we make a distinction between episodic liquidity risk and incremental liquidity risk.

Firstly, liquidity risk can be defined as the risk that assets cannot be sold in a timely and cost-efficient manner in order to meet funding obligations. This is episodic liquidity risk. Episodic liquidity risk has two sides to it: asset liquidity risk and funding liquidity risk. Asset liquidity risk arises if transactions cannot be conducted at the quoted market prices due to the size or time constraints of the required trade, or, worse still, cannot be conducted at all. Funding liquidity risk relates to the ability to redeem clients without significantly impacting the value of the portfolio. This kind of risk will only arise if asset liquidity is limited, so the latter is dependent on the former.

One side of liquidity which is often overlooked is investor dilution. Investor dilution occurs due to subscriptions and redemptions in a fund as these transactions cause transaction charges for the fund. This is referred to as incremental liquidity risk. Incremental liquidity risk is more pronounced in illiquid markets, as the transaction charges are high in these markets compared to the size of the transaction. Incremental liquidity risk is the silent assassin of fund performance and investor returns.

'One side of liquidity risk which is often overlooked is investor dilution'

In February 2018, IOSCO (International Organization of Securities Commissions) published a number of recommendations[1] addressing the vulnerabilities in the financial system arising from the liquidity risk of asset management activities. The recommendations state that a manager should design an effective liquidity risk management framework. In their view, for a liquidity risk management framework to be effective, it should not only be proportionate, but it should also be flexible enough to take varied market conditions into account. Furthermore, it should consider the liquidity of all types of instruments in the portfolio with an appropriate level of granularity and should be able to ensure that the fund is able to comply with redemption obligations and other liabilities.

[1] IOSCO, February 2018, *Recommendations for Liquidity Risk Management for Collective Investment Schemes*, available via: http://www.iosco.org/library/pubdocs/pdf/IOSCOPD590.pdf.

Objective and outline

So far, we haven't come across a comprehensive description of a liquidity risk management framework for open-ended investment funds that effectively addresses both types of liquidity risk (episodic and incremental) and takes all the IOSCO recommendations into account.

This white paper describes Robeco's liquidity risk management framework and how it deals with the relevant aspects of liquidity risk by using MSCI's LiquidityMetrics. In so doing, we hope to raise the bar for liquidity risk management frameworks and contribute to an industry-wide discussion as to what constitutes effective liquidity risk management.

In the next chapter, we discuss Robeco's liquidity risk management framework and its various components. In the chapter 3 we discuss the essential role played by liquidity risk monitoring in the liquidity risk management framework; we outline the fundamentals of liquidity risk monitoring and how MSCI's LiquidityMetrics can be used for that purpose. Finally, in Chapter 4 we summarize the framework and its value-added.

Liquidity risk management framework

In this chapter we discuss the liquidity risk management framework and the various components we deem essential for it to be effective.

An effective liquidity risk management framework should aim to prevent and mitigate liquidity risk from arising. For this reason, it should prescribe both ex-ante and ex-post liquidity risk management tools. Ex-ante liquidity risk management tools are designed to prevent the liquidity risk from arising. Ex-post liquidity risk management tools are designed to limit the impact of the liquidity risk once it has arisen.

Furthermore, an effective liquidity risk management framework should address the problem of episodic liquidity risk issues (e.g. large redemptions in combination with liquidity stress) as well as daily incremental accumulation of liquidity effects known as investor dilution, or incremental liquidity risk.

The ex-ante tools used at Robeco are: frequent liquidity monitoring, liquidity buffers, borrowing facilities and concentration limits on illiquid exposures.

'Measuring and monitoring of liquidity risk is the cornerstone of any liquidity risk management framework'

The ex-post tools available to Robeco are: swing pricing, redemption gates, deferrals, anti-dilution levies and suspensions of redemptions.

Liquidity Risk Management Framework			
		Incremental Risk	Episodic Risk
Ex Ante	> Measuring & Monitoring	v	v
	> Liquidity buffers	v	v
	> Borrowing/repos		v
	> Concentration limits		v
Ex Post	> Swing pricing	v	
	> Anti-dilution levies		v
	> Redemption gates/deferrals		v
	> Temporary suspension		v

Table 1: Liquidity risk management framework. Source: Robeco

[2]Available from https://www.esma.europa.eu/databases-library/esma-library/%22risk%20dashboard%22

Several of these ex-post tools are part of the liquidity contingency plan. These are the extraordinary liquidity risk management tools. The decision to use them should not be taken lightly as they limit the liquidity offered by the fund, which has negative consequences for clients and could damage the manager's reputation. Table 1 provides a schematic overview of the liquidity risk management framework.
We discuss the measures in detail below.

Ex-ante liquidity risk management tools

Ex-ante – measuring & monitoring: measuring and monitoring of liquidity risk is the cornerstone of any liquidity risk management framework. Without proper insight into the liquidity risk of a fund, it's impossible to decide on the appropriate preventive or mitigating measures. The monitoring of liquidity risk can take place on a portfolio level and a market level. We detail the approach to the measuring and monitoring of portfolio liquidity risk with MSCI's LiquidityMetrics in the next chapter.

As for the portfolio liquidity risk measures, it is important that they are effective in varying market conditions. It is therefore equally important to have a good understanding of the market conditions. In addition to measuring and monitoring portfolio liquidity risk, it is important to monitor market conditions with regard to funding liquidity and asset liquidity, too. Evaluating industry-wide fund flows is one way in which funding liquidity can be monitored. The liquidity measures such as those included in the quarterly ESMA Risk dashboard might be used to monitor asset liquidity risk[2].

The general principle that applies to the monitoring of portfolio liquidity is that liquidity supply should be sufficient to meet liquidity demand. If liquidity supply is not sufficient, additional ex-ante liquidity tools might be necessary.

Ex-ante – liquidity buffer: In order to ensure a minimum amount of asset liquidity, a minimum cash buffer may be applied. A cash buffer (or cash alternatives such as reverse repos) is an effective liquidity risk management tool. Using a cash buffer to redeem shares in the fund is a time- and cost-efficient method; there's no need to enter the market. However, cash buffers will need to be replenished if they are used and if there are no subsequent subscriptions. Furthermore, cash buffers (with returns close to zero) impact the performance of a fund. To minimize this effect, cash buffers may be 'equitized' with futures or other derivatives.

Ex-ante – borrowing facilities: Funds may use a temporary borrowing facility (e.g. up to 10% under the UCITS regulations) to provide the cash to redeem shares. However, this is not the most desirable approach, as borrowing creates leverage and could increase the liquidity risk in the fund.

An alternative approach is to use repurchase agreements (repo) to generate cash. Similar to borrowing, when used to redeem shares, repos create leverage in the fund. To avoid exacerbating liquidity risk, the extent of repos being used as well as their term can be limited. The rule-of-thumb is that borrowing facilities or repos should only be used if one is certain that the necessary sell trades can be carried out in time and when less drastic ex-ante measures have been exhausted.

'We believe that protecting shareholders of a mutual fund from investor dilution is part of our role as good stewards of our clients' investments'

Ex-ante – concentration limits: Significant exposures to asset classes that are, by definition, illiquid are not desirable. These exposures should be limited in order to minimize the liquidity risk associated with them. The appropriate limit is dependent on the asset class and its liquidity and should be determined on a case-by-case basis.

Ex-post liquidity risk management tools

Ex-post – swing pricing: Swing pricing is one of the essential components of the ex-post liquidity management tools available to an asset manager.[3] Swing pricing minimizes investor dilution.

Incremental liquidity risk manifests as investor dilution. Investor dilution occurs due to subscriptions and redemptions in a fund as these transactions result in transaction charges for the fund. The costs of these transactions are initially borne by the fund and its shareholders, decreasing the value of the fund and causing the dilution. This creates a conflict of interest between the existing shareholders of a fund and the investors who enter or exit the fund.

A widely accepted solution for mitigating investor dilution is swing pricing. This mechanism reallocates the transaction costs from the shareholders to the trading investor. Swing pricing is used first and foremost as a mechanism for safeguarding the value of the fund and the return for its shareholders. The revenues of swing pricing are to the full benefit of the fund and its shareholders. If a trading investor is impacted by a price swing when subscribing to or redeeming their investment in a fund, they are paying or receiving an amount, which includes the costs of trading. These trading costs would have also been incurred if the investors had been trading directly in the underlying securities. In fact, the trading costs would have been higher since at least some of the redemptions and subscriptions for a given day cancel each other out.

There are two common approaches to swing pricings: full and partial swing pricing. With partial swing pricing, swing pricing is only applied if a certain threshold (net cash flow relative to fund size) is exceeded. However, with full swing pricing, swing pricing is applied on each day with net cash flow. By having a threshold, it is acknowledged that smaller transactions can frequently be managed within the existing cash position (i.e. cash buffer) of the fund and consequently do not always have to lead to transaction costs.

In the absence of swing pricing, every investor gets a 'one-off bonus' (no transaction costs for subscriptions and redemptions) but pays daily 'hidden fees' as the fund's performance suffers due to transaction costs being incurred as a result of the net subscriptions or redemptions associated with trading. Furthermore, the costs incurred by the investor as a result of swing pricing are bounded (at no more than twice the swing price) but the dilution effect is unbounded and will accumulate, especially for long-term investors. Alternatively, swing pricing could also be considered an 'entrance fee' to a fair game.

We believe that protecting shareholders of a mutual fund from investor dilution is part of our role as good stewards of our clients' investments. For that reason, Robeco, was one of the first to adopt swing pricing.

[3] Swing pricing is not a feasible solution for US mutual funds because of the current operational conventions with regard to the NAV dissemination and its interdependence with subscriptions and redemptions.

Ex-post – anti-dilution levies: When net subscriptions or redemptions increase in size, the swing price no longer covers the transaction costs incurred, as large volume trading will have an additional market impact. In order to protect the remaining investors from the episodic dilution effects of large net cash flows, anti-dilution levies may be imposed discretionarily.

A threshold for subscriptions and redemptions is determined for each fund. Above the threshold, the effect of market impact is deemed too big and the anti-dilution levy will take effect. The level of the anti-dilution levy is determined on a case-by-case basis and is aimed at minimizing the dilution resulting from the market impact of large net cash flows. MSCI's LiquidityMetrics is used to calculate the appropriate level of the anti-dilution levy.

Ex-post – liquidity contingency plan: A liquidity contingency plan outlines the course of action to take when funds are exposed to liquidity challenges which cannot be solved by means of the regular liquidity management tools discussed above. The plan's goal is to make sure that decision-makers are well-informed, that the process is properly documented and that the right people are involved if any of the extraordinary liquidity management tools are used.

The extraordinary liquidity management tools that may be used are: redemption gates, deferrals and suspension of the net asset value (NAV) calculation (effectively suspending subscriptions and redemptions). In any case, the extraordinary liquidity management tools that might be used should be detailed in the offering documents of the fund. Several of the tools available are described below.

'The decision to use extraordinary liquidity risk management tools should not be taken lightly'

Ex-post – redemption gates & deferrals: Gating refers to the practice of limiting the amount of redemptions on given a day to a predetermined percentage of the NAV. Dealing with the redemptions exceeding the limit will be prioritized on the next day over later redemption requests and in the order that the requests were initially received. Gating limits the liquidity demand on a given day and decreases the short-term impact of the liquidity risks. Gating is not a popular tool as it affects clients' access to their investment, causes problems with waiting times and might be considered an early warning signal of structural liquidity problems in a fund, potentially triggering the fund equivalent of a bank run.

Deferrals refer to the practice of postponing the payment of a redemption (without interest) in the case of exceptional circumstances during which the liquidity of a fund is not sufficient to make the payment. Deferrals have most of the same pros and cons as gating. By using deferrals, the redemption price is fixed and thereby the liquidity risk is transferred from the redeeming client to remaining clients.

Ex-post – Suspension of NAV/subscriptions & redemptions: The determination of the NAV, and hence redemptions and subscriptions, may be suspended. This is usually considered the most drastic liquidity risk management tool available as it negates any subscriptions and redemptions in the fund. It is commonly described as the measure of last resort. However, NAV suspensions of UK real estate funds after Brexit made clear that the measure is not necessarily irreversible[4].

[4] For example see: https://www.fca.org.uk/publications/multi-firm-reviews/review-property-funds-and-liquidity-risks and https://www.professionaladviser.com/professional-adviser/news/2478195/aviva-investors-to-lift-suspension-on-property-trust

Liquidity risk monitoring with MSCI's LiquidityMetrics

In this paper we focus in particular on the parts of the liquidity risk management framework concerned with the measuring and monitoring of liquidity risk.

Liquidity risk can be divided into asset liquidity and funding liquidity. The framework offers an approach for measuring and monitoring asset liquidity, funding liquidity and liquidity shortfall. In order to conceptualize the monitoring of liquidity risk we have redefined asset liquidity as liquidity supply and funding liquidity as liquidity demand. As such, the monitoring of liquidity risk can be reduced to the following, simple formula:

Figure 1: A simple formula for monitoring liquidity risk. Source: Robeco

To determine the liquidity supply, we use MSCI's LiquidityMetrics. In the remainder of this chapter, we first discuss MSCI's LiquidityMetrics, after which we describe how we use it to determine the liquidity supply. We then discuss our approach to determining the liquidity demand. Finally, we explain how subtracting the liquidity demand from the liquidity supply results in a liquidity surplus or shortfall and how this should be monitored.

MSCI's LiquidityMetrics

In June 2013, MSCI's Carlo Acerbi and Zsolt Szekeres published the paper 'Introduction to LiquidityMetrics'[5], in which they propose a new way to measure liquidity risk. They observe that there is no standard model, or even language, to address liquidity risk rigorously and comprehensively. They seek to establish a universal model and language for liquidity risk on a portfolio level and argue – in our view, convincingly – that LiquidityMetrics is suitable for this purpose.

When discussing the measurement of asset liquidity one should be mindful of the differences between asset classes, primarily between equities and bonds. In general, equities are traded on an exchange with an open order book. This enables transparency in terms of bids and offers and trading volume.

The most common approach for measuring the liquidity risk of equities is to calculate the days to liquidate by using trading volumes. Bonds on the other hand are traded by brokers, a process often referred to as over-the-counter (OTC) trading. As a consequence, bond trading is not transparent. A frequently-used approach is to classify bonds into liquidity buckets based on their bid-ask spreads. Each of these approaches has several disadvantages (see Chapter 2 of 'Introduction to LiquidityMetrics').

LiquidityMetrics builds on the premise that liquidity is best understood as three-dimensional. It acknowledges the interplay between the transaction costs, order size and liquidity horizon. These three aspects of liquidity risk can be seen as the three 'dimensions' of liquidity risk. Together, these three dimensions shape the so-called liquidity surface.

5 Executive summary available at: https://www.msci.com/www/blog-posts/measuring-liquidity-risk/0248187846; for the full paper contact MSCI via their website: https://www.msci.com/contact-us

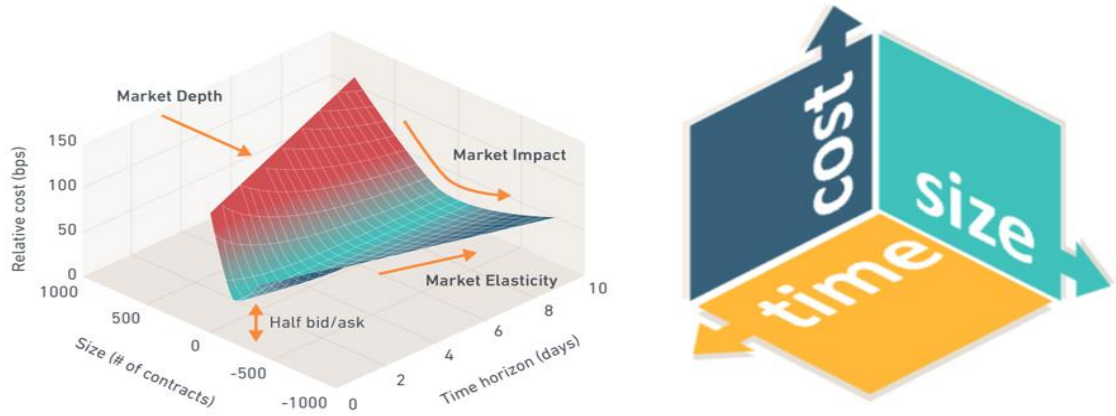

Figure 2: Liquidity risk is a three-dimensional surface. Source: MSCI

The three-dimensional liquidity surface has the following features which can be observed directly:

- The bid-ask spread refers to the transaction costs associated with a small order size on a given time horizon and is plotted on the vertical axis of the liquidity surface. The maximum order size that can be traded with this bid-ask spread is called the normal market size.
- The market impact comes into play for larger orders when the transaction costs increase. The slope of the cost curve along the horizontal axis (size) on a given time horizon indicates the market impact.
- The market elasticity is the measure of how rapidly the market regenerates liquidity after a larger order has been absorbed. The slope of the liquidity surface on the depth axis (time) for a given order size represents the market elasticity.
- The maximum order size that can be bought or sold on a given horizon regardless of the costs is referred to as the market depth. Market depth truncates the surface on the horizontal axis.

This rigorous model can be applied to bonds and equities alike. The way the surfaces are constructed differs by asset class. For equities, MSCI receives the data to construct a liquidity surface from ITG, a market leader in trading analytics (commonly used by the trading desks for reporting transaction costs). ITG cost curves are estimates of market impact, for a given stock, size and a trading strategy. These cost estimates are based on an econometric model that is then calibrated using institutional peer group trading data.

Data scarcity presents a challenge for the modelling of liquidity risk for fixed income securities, since bonds are traded OTC. LiquidityMetrics first tackled this challenge with the so-called Liquidity Observatory, which aims to reach market consensus on the parameters of the liquidity surface. It is a quantitative and systematic monthly survey that is completed by buy-side trading desks. In September 2017, MSCI announced it had entered into an alliance with IHS Markit to improve the data inputs (dealer quotes, order sizes and trading volumes) for the liquidity surface parameters for fixed income and other OTC

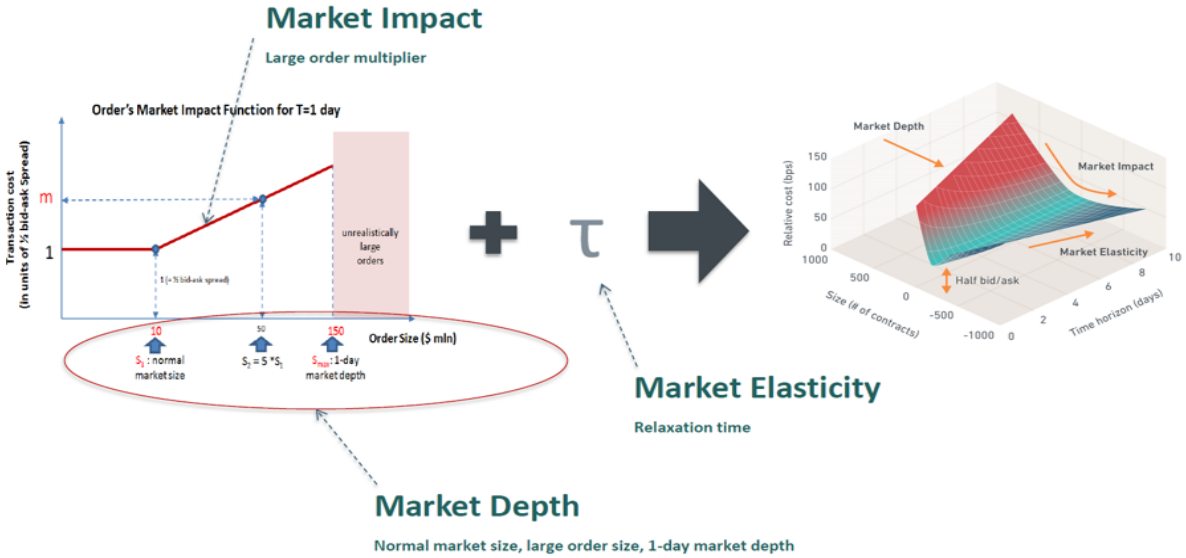

Figure 3: How to construct a liquidity surface. Source: MSCI

securities in LiquidityMetrics.

Liquidity supply

As discussed above, asset liquidity is a function of three variables: time, size and cost. Liquidity supply is the part of the portfolio that can be sold within a certain timeframe at acceptable transaction costs. For calculating liquidity supply one has to consider the appropriate timeframe, the maximum acceptable transaction cost and the appropriate liquidation scenario.

Choosing the appropriate timeframe for the analysis can be done in multiple ways. Usually, you want to know how much liquidity supply there is for multiple time horizons. AIFMD and SEC regulations stipulate specific requirements for the time horizons used. Another frequently used approach is to calculate the liquidity supply for a single day, week (five business days) and month (20 business days).

Determining the maximum acceptable transaction cost is not a straightforward task. Transaction costs vary by asset class. Even within a given asset class, the assets may have different characteristics, calling for a more granular approach. We identify different approaches for determining the maximum acceptable transaction fee for equities and for fixed income.

'Calculating liquidity supply one has to consider the appropriate timeframe, the maximum acceptable transaction cost and the appropriate liquidation scenario'

Another aspect that must be considered is the liquidation scenario. It can range from proportional liquidation (i.e. a vertical slice of the portfolio) to a waterfall liquidation during which the most liquid assets are sold first. In principle, each investor has the right to a share of the whole portfolio proportional to the size of their investment. In a waterfall liquidation, the most liquid positions in a portfolio are sold first, after which the remaining investors hold a less liquid portfolio than before the liquidation. Requiring proportional liquidation reduces the chance of such a scenario occurring and presents a fair image of the portfolio's liquidity.

We take two different approaches to determining these parameters for equities and fixed income.

Equities: For equity portfolios, we determine the maximum acceptable transaction cost by looking at the swing price level of the fund. The rationale here is that if you pay more than the swing price, the remaining clients will bear the extra costs incurred as a result of redemptions with investor dilution increasing as a result.

When investor dilution arises as a result of subscriptions and redemptions, it directly undermines the principle of equal treatment of all clients, especially because longer-term investors will then in effect be paying for shorter-term investors.

The same principle also implies that each investor has the right to a share of the entire portfolio in proportion to the size of their investment. This, in turn, means that in order to enable a redemption, a proportional part or fair slice of the portfolio should be sold.

Additionally, we recognize that cash is a liquidity tool often used by portfolio managers as a buffer to accommodate outflows. This is also reflected in the use of partial swing pricing. Hence, the requirement of proportionality does not apply to cash.

In summary:

- Cash + the proportion of the portfolio that is liquid within transaction cost limit = liquidity supply

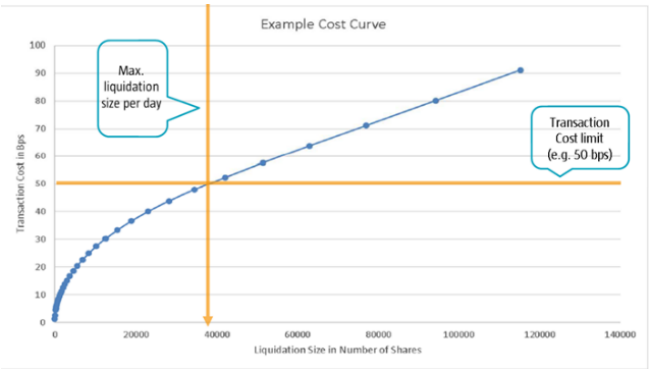

Figure 4: A graphic representation of the equity approach. Source: Robeco

Fixed income: For fixed income portfolios, we determine the maximum acceptable transaction cost as the costs associated with the maximum order size that can be traded without there being any additional market impact (the no market impact approach). The transaction cost curve for bonds is flat until the normal market size (i.e. the maximum order size that can be traded against half of the bid-ask spread) is reached, after which the transaction costs rise above the level of half of the bid-ask spread. Consequently, with the no market impact approach, the maximum liquidation size per day is equal to the normal market size. Furthermore, given that the bid-ask spread plays an important part in determining the swing price level, it is therefore also linked to the swing price level in much the same way as it is for equity portfolios.

We acknowledge that the application of a proportional liquidation scenario should not be enforced with the same rigor for fixed income as it is for equities. A fixed income portfolio can be classified based on the exposures it has to interest rates and issuer-specific risks. A portfolio can

maintain the same exposures to interest rates and issuer-specific risks while its composition changes on a position level. Therefore, proportional liquidation is not considered a requirement for fixed income. However, under the normal market size assumption we can always sell the normal market size. Consequently, relaxing the proportionality does not necessarily allow a waterfall liquidation to occur.

In summary:

- Cash + $\sum_{i=1}^{N} NMS_N$ = liquidity supply

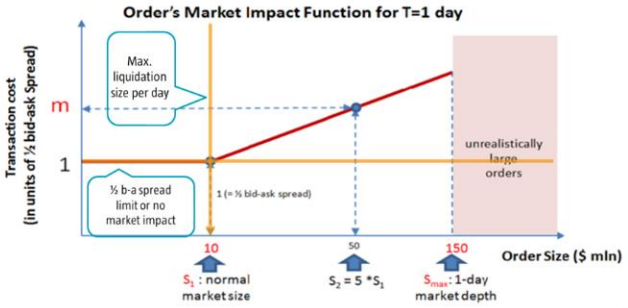

Figure 5: A graphic representation of the fixed income approach. Source: MSCI & Robeco

Stressed liquidity supply: The calculations described so far are based on normal market conditions. It is important to consider the liquidity conditions of a fund in a stressed environment, as well. Liquidity stress tests are designed to simulate the scenario of a significant liquidity drought. The asset liquidity stress test we apply is a market depth shock. Market depth is the maximum order size that can be bought or sold on a given time horizon regardless of the costs. Decreasing the market depth lowers the total amount of liquidity available per instrument and simultaneously reduces the normal market size for fixed income (implying you can sell less at an acceptable cost) and increases the slope of the cost curve for equities (idem). As a result, the maximum order size you are able to trade per day decreases while the transaction costs per trade increase. The level of the market depth shock may be determined based on historical events or hypothetical scenarios.

'Redemption risk is notoriously hard to model'

Recommendations published in February 2018 by the European Systemic Risk Board[6] suggest that the publication of additional regulatory guidance with regard to liquidity stress testing can be expected.

[6] Available at: https://www.esrb.europa.eu/news/pr/date/2018/html/esrb.pr180214.en.html

Liquidity demand

After determining the liquidity supply, the next step is to determine the funding liquidity profile or the liquidity demand of the fund.

Funding liquidity risk arises if there are large redemptions but also in the case that variation margin (VM) requirements as a result of mark-to-market of derivatives. Redemption risk is notoriously hard to model. To do so, we look at two different scenarios: historical redemption scenarios and hypothetical redemption scenarios.

Historical redemption scenarios: One way of tackling the challenge of modeling redemption scenarios is by looking at historical redemptions of a fund. We assume that the historical redemptions in each fund have some predictive power for future redemptions in that fund. We use the largest outflows of each fund for the different time horizons to model the historical redemption scenarios.

Hypothetical redemption scenarios: We use the current client composition of the fund as a starting point for determining the hypothetical redemption scenario. Different types of clients display different investment behavior. We differentiate three types of clients: institutional clients, discretionary-distribution clients and diversified-distribution clients.

Institutional clients are large (financial) institutions such as insurance companies or pension funds that have a thorough understanding of financial markets. It is commonly assumed that institutional investors are less fazed by financial turmoil and have a long-term investment perspective. However, it takes one investment decision to redeem their entire investment in a fund. Consequently, institutional investors are less likely to redeem but when they do, it may have big impact.

We define discretionary distribution clients as those distribution clients that assist their clients in their investment decisions, for example by means of a managed fund or model portfolio. The investment decision to include or exclude a Robeco fund in the managed fund or model portfolio is made by a single professional party. Although the discretionary distribution client is less likely to redeem the entire amount invested, there is still some risk.

According to our definition, diversified distribution clients are those that take their investment decisions independently. The diversified distribution client is, in fact, a diversified group of (retail) clients that act independently of each other. We therefore treat the set of diversified distribution clients as a single pool of clients that tend to 'follow the crowd' (i.e. herding). Retail

clients are often thought to act less rationally than professional investors. Hence, redemption might be more likely, but the order sizes being redeemed are likely to be smaller. We therefore assume that a percentage of the entire client group will redeem within several days.

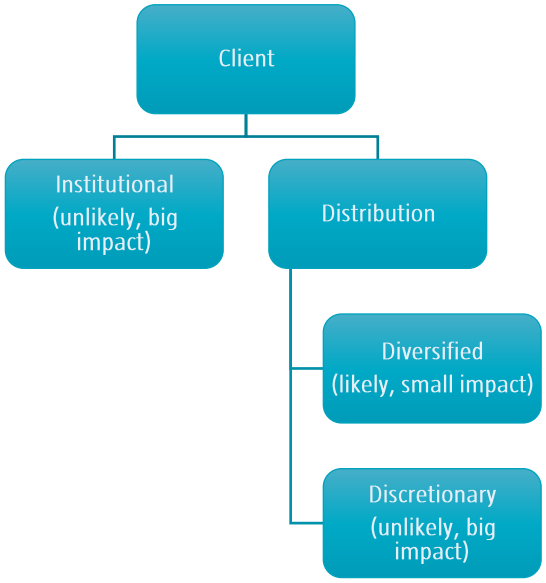

Figure 6: Different clients, different risks. Source: Robeco

Taking the two alternative approaches into account gives us a nuanced view on a fund's redemption risks, which are notoriously hard to model. Redemptions are however not the only liabilities of a fund.

Variation margin: Funds with derivatives in the portfolio have an additional source of liquidity demand. Variation margin (VM) as a result of the marking-to-market of the derivatives in the portfolio, must be paid in cash. As such, the cash demand is dependent on the market value fluctuations of the derivatives and thus on the riskiness of the derivatives. We calculate the cash demand from margin and collateral by means of the value at risk (VaR) for the derivatives in the portfolio. This VaR expresses the maximum liquidity demand from the variation margin that can be expected with a certain degree of confidence.

Liquidity shortfall/surplus

The standalone measures of liquidity supply and liquidity demand are useful, but are really effective for the purposes of monitoring liquidity risk when they are combined. The liquidity supply of a fund minus its liquidity demand may result in a liquidity surplus or liquidity shortfall.

By combining the liquidity supply and liquidity demand (as detailed above), we can calculate the liquidity shortfall or surplus. Four different liquidity scenarios result from the different calculations:

	Historical redemption scenario	Hypothetical redemption scenario
Normal liquidity supply	Normal historical scenario	Normal hypothetical scenario
Stressed liquidity supply	Stressed historical scenario	Stressed hypothetical scenario

Table 2: Four different scenarios to monitor. Source: Robeco

In this Table 2:

- Normal historical scenario = normal liquidity supply – VM – hist. redemption
- Normal hypothetical scenario = normal liquidity supply – VM – hyp. redemption
- Stressed historical scenario = stressed liquidity supply – VM – hist. redemption
- Stressed hypothetical scenario = stressed liquidity supply – VM – hyp. redemption

Monitoring four different scenarios results in a number of combinations of potential liquidity shortfalls. The combination determines the severity of the situation and the consequence of the shortfall. The following set-up is applied:

Number of scenarios with a shortfall	Risk severity
None	Zero
One	Low
Two	Medium
Three	High
Four	Very high

Table 3: Risk severity table. Source: Robeco

The liquidity risk calculations include all the relevant aspects of liquidity risk and incorporate multiple (stressed) scenarios. The calculations are translated into an intuitive liquidity risk severity score. Measuring and monitoring liquidity risk comprehensively does not have to increase the complexity.

Conclusion

This paper started with the aim of describing an effective liquidity risk management framework. We have summarized Robeco's liquidity risk management framework and why we believe it is effective.

Robeco's liquidity risk management framework is designed to address episodic and incremental liquidity risks. Ex-ante and ex-post liquidity risk management tools are used for preventing and mitigating the effects of episodic and incremental liquidity risk.

The measuring and monitoring of liquidity risk is the cornerstone of this framework. We believe Robeco's approach for measuring and monitoring liquidity risk by using MSCI's LiquidityMetrics is, for all intents and purposes, comprehensive, because it:

- deals with episodic and incremental liquidity risk
- includes the three dimensions of asset liquidity
- takes stressed liquidity circumstances into account
- uses two distinct approaches to estimate redemption risk and
- includes variation margin liabilities.

Furthermore, the measuring and monitoring is predicated on one simple assumption: that liquidity supply minus liquidity demand equals the liquidity surplus or shortfall and results in a portfolio liquidity risk severity score that is easy to understand.

Finally, and without question, it fulfills the requirements of all regulations applicable to Robeco funds (e.g. the UCITS directive and AIFMD) and is also equipped to meet the demands of regulatory developments such as those anticipated in IOSCO recommendations. Please refer to the Appendix 1 for an overview of the recommendations and a description of how Robeco applies them.

Appendix

In February 2018, the international Organization of Security Commissions (IOSCO) published its final recommendations for liquidity risk management for Collective Investment Schemes (CIS). These recommendations form the basis for legislators to adapt their regulations with regard to liquidity risk management. In order to be able to anticipate changes in the regulations, we have performed an analysis of Robeco's status with regard to these recommendations.

The results of our analysis on basis of the 17 recommendations are presented below.

Recommendation 1

"The responsible entity should draw up an effective liquidity risk management process, compliant with local jurisdictional liquidity requirements."

Robeco has developed an effective liquidity risk management framework, which is detailed in this paper. The liquidity risk management process is documented in the liquidity risk policy. The liquidity risk management framework takes different asset classes and different market liquidity conditions into account by means of liquidity stress testing. The liquidity risk policy is reviewed annually, or more frequently if necessary, and is continuously being improved.

Recommendation 2

"The responsible entity should set appropriate liquidity thresholds which are proportionate to the redemption obligations and liabilities of the CIS."

Robeco's liquidity risk management framework is founded on the principle that asset/portfolio liquidity should be sufficient to meet the requirements of extreme funding liquidity (e.g. redemption) scenarios. If they fail to do so, the liquidity situation is investigated thoroughly and additional measures are taken, if necessary.

Recommendation 3

"The responsible entity should carefully determine a suitable dealing frequency for units in the CIS."

Liquidity is an important criterion in the product design and approval process of Robeco funds. The majority of our funds have a daily redemption frequency. If we know in advance that the asset liquidity of a particular fund is not sufficient to allow for a daily redemption frequency, that fund should not be assigned a daily redemption frequency.

Recommendation 4

"The responsible entity should ensure that the CIS' dealing (subscription and redemption) arrangements are appropriate for its investment strategy and underlying assets throughout the entire product life cycle, starting at the product design phase."

Almost all of our products are open-ended. As such, their life cycle is, all things remaining equal, indefinite and static.

Recommendation 5

"The responsible entity should consider liquidity aspects related to its proposed distribution channels."

We have sufficient information about client concentrations in the funds, but not on the level of beneficial owners. We take the different distribution channels into account by differentiating funding liquidity risk approaches for institutional investors and discretionary distribution and diversified distribution clients. Finally, we take industry-wide cashflow information into account in analyzing funding liquidity risk.

Recommendation 6

"The responsible entity should ensure that it will have access to, or can effectively estimate, relevant information for liquidity management."

The information considered ranges from liquidity risk estimations on an instrument level derived from LiquidityMetrics to funding liquidity arrangements such as redemption frequency, swing pricing and anti-dilution levies.

Recommendation 7

"The responsible entity should ensure that liquidity risk and its liquidity risk management process are effectively disclosed to investors and prospective investors."

In the prospectuses of Robeco funds, several chapters are dedicated to liquidity risk and the liquidity risk

management process. Take the Robeco Capital Growth Fund prospectus, for example (https://www.robeco.com/docm/pros-cgf-general.pdf). Section 2 describes the redemption policy, as well as any liquidity management tools that are available to the management company. Section 4 explains the risk considerations, paying special attention to liquidity risk. Finally, in Appendix III, the financial risk management process is discussed, with liquidity risk as one of three main focus areas. All of the above texts are reviewed and updated by Robeco's independent risk management department on a regular basis.

Recommendation 8

"The responsible entity's liquidity risk management process must be supported by strong and effective governance."

Robeco's liquidity risk policy describes the governance in relation to the risk management process. As a consequence of the selected 'three-lines-of-defense' model, liquidity risk is, first and foremost, the responsibility of portfolio management. The risk management serves as an independent, second line of defense. Risk management reports any relevant liquidity risks to dedicated risk governance committees that are well-equipped and independently situated to take action on such issues. Separately, the interrelationship between liquidity risk and valuation is addressed by independent valuation committees. Furthermore, separate governance in relation to the deployment of extraordinary liquidity management tools is described in Robeco's liquidity contingency plan. In this way, Robeco ensures independent oversight and appropriate escalation procedures are in place.

Recommendation 9

"The responsible entity should effectively perform and maintain its liquidity risk management process."

Robeco's risk management department is responsible for the execution, periodic review and maintenance of Robeco's liquidity risk management framework and the liquidity risk policy and reports on these activities to the relevant governing entities.

Recommendation 10

"The responsible entity should regularly assess the liquidity of the assets held in the portfolio."

Liquidity risk is measured and monitored on a weekly basis, and more frequently if deemed necessary. The methodology for measuring and monitoring liquidity risk is sufficiently documented in this paper, but also in the liquidity risk policy.

Recommendation 11

"The responsible entity should integrate liquidity management in investment decisions."

In addition, to any liquidity risk assessments they perform themselves, portfolio managers receive the results of the liquidity risk calculations carried out by the risk management department on a weekly basis in order for them to take this information into account in the investment process.

Recommendation 12

"The liquidity risk management process should facilitate the ability of the responsible entity to identify an emerging liquidity shortage before it occurs."

Robeco's liquidity risk management framework takes stressed asset and funding liquidity risk into account. Furthermore, redemptions are monitored by the risk management department to identify any potential liquidity risk as soon as possible. If the beginnings of a liquidity shortage are identified in the monitoring process, the liquidity contingency plan may be implemented. The liquidity contingency plan sees to it that the emerging liquidity shortage is handled with due consideration of the principle of fair treatment of all investors.

Recommendation 13

"The responsible entity should be able to incorporate relevant data and factors into its liquidity risk management process in order to create a robust and holistic view of the possible risks."

Robeco's liquidity risk management framework employs state-of-the-art asset liquidity calculations in the use of MSCI's LiquidityMetrics in combination with detailed investor base information, historical redemption scenarios and variation margin requirements. This combination provides a robust and holistic view on the relevant aspects of liquidity risk.

Recommendation 14

"The responsible entity should conduct ongoing liquidity assessments in different scenarios, which could include fund level stress testing, in line with regulatory guidance."

Robeco's liquidity risk management framework takes stressed liquidity into account in two ways. First, asset liquidity is calculated under stressed liquidity conditions. Second, funding liquidity risk is considered by means of two different funding liquidity scenarios (historical and hypothetical) that are extreme but not impossible.

Recommendation 15

"The responsible entity should ensure appropriate records are kept, and relevant disclosures made, relating to the performance of its liquidity risk management process."

Ex ante liquidity risk concerns are reported to the risk governing committees and decision- making is recorded in the minutes of the committees. The relevant liquidity risk management tools are disclosed in a fund's prospectus. Investors are informed of the changes to the

prospectus. The liquidity risk and the nature of the liquidity risk management tools are disclosed to regulators via frequent regulatory reporting.

Recommendation 16
"The responsible entity should put in place and periodically test contingency plans with an aim to ensure that any applicable liquidity management tools can be used where necessary, and if being activated, can be exercised in a prompt and orderly manner."

Robeco has a liquidity contingency plan governing the use of extraordinary liquidity management tools. The liquidity contingency plan is frequently reviewed and updated to align it with the current state of affairs.

Recommendation 17
"The responsible entity should consider the implementation of additional liquidity management tools to the extent allowed by local law and regulation, in order to protect investors from unfair treatment, amongst other things, or prevent the CIS from diverging significantly from its investment strategy."

The liquidity contingency plan provides for the use of most of the liquidity management tools that are relevant and allowed under the local laws and regulations. Whether or not it is practical to use such liquidity management tools in a particular situation is up to the bodies carrying out the liquidity contingency plan.

In conclusion, Robeco's liquidity risk management framework is well-positioned to anticipate new regulatory standards put forward by IOSCO.

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