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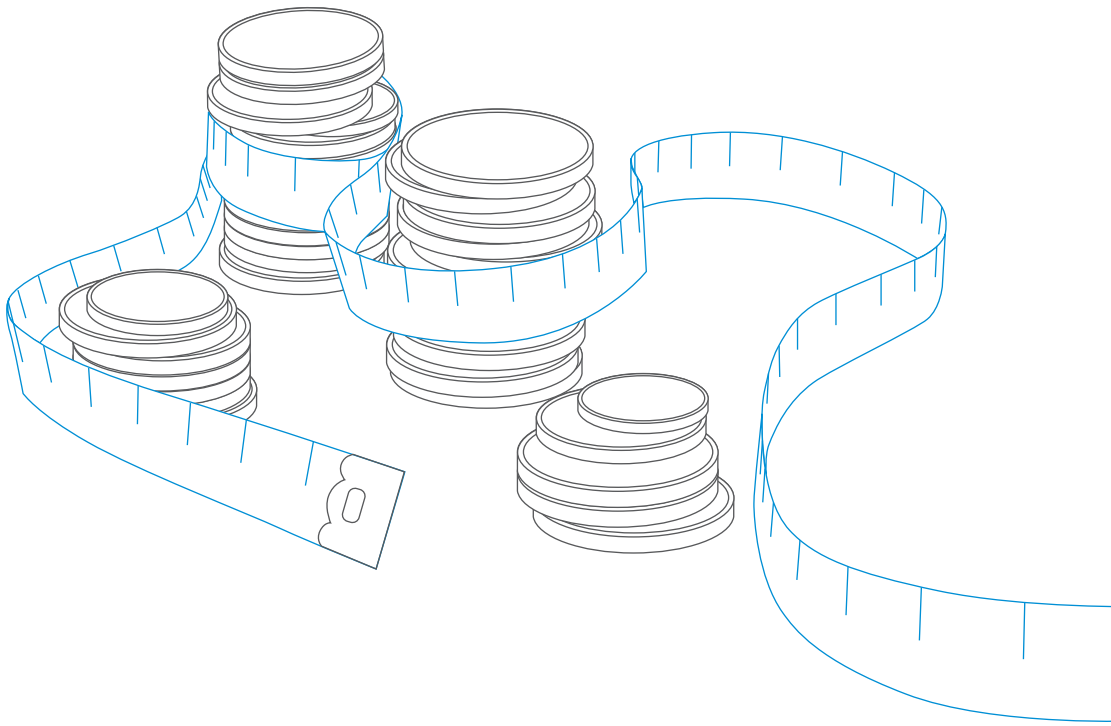
The value of liquidity

Can it be measured?

June 2010



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Foreword

The notion of liquidity has never been more relevant or as frequently referenced as it is today. But what precisely does liquidity entail and why is it so important? Theoretically, it is the ability to readily access funds when needed at a minimal cost. Practically, however, it is much more complex to define and is a broad concept that affects us all in one form or another (e.g., the availability of loans at affordable (yet risk adjusted) rates, the ability to fund transactions, free movement of cash flows, inter-bank loans and inter-country borrowing). The latter, in the wake of the current European sovereign debt crisis, has reached new dimensions with a EUR 750 bn bailout to help struggling countries meet their obligations and ensure monetary stability. Without this injection of liquidity, there could be far reaching economic and social consequences that would transcend national boarders. However, it remains to be seen if these measures are sufficient, as recent economic indicators suggest that liquidity may still be constricting, particularly within the "PIIGS" countries.

Looking at the concept of liquidity through the lens of the asset owner, liquidity is simply the ability to buy and sell assets on the markets at "fair" prices within a given timeframe. Indeed, there is little else of greater importance to ensure the smooth functioning of capital markets than sufficient liquidity. Liquidity can be regarded as a barometer of overall economic well-being.

The credit crunch was in essence a liquidity crisis where major stock market selloffs led to a freeze in liquidity. In particular, after the Lehman Brothers default in 2008 some markets ceased trading altogether increasing investor panic and putting further pressure on financial markets. In early 2010, there were signs of economic recovery and stability. Yet bid-offer spreads have recently started to increase again, in response to the current Eurozone sovereign debt crisis.

From a monitoring perspective in Europe, the UCITS framework lays out requirements for asset managers to monitor and prove optimal liquidity to investors. This very notion is embedded in the acronym "UCITS" where "TS" stands for "transferrable securities". The UCITS brand attracts large numbers of institutional and retail investors who need to be able to subscribe or redeem fund units at any time. Prior to 2008, asset liquidity under the UCITS framework was more or less guaranteed and investors expressed little concern. However, in the wake of events throughout 2008 and 2009 this paradigm has shifted.

Investors and regulators globally have become more focussed on measures to ensure investor protection and are re-evaluating risks related to liquidity within asset pools. There is a call for greater transparency and increased disclosure of the various risks in the marketplace and increasingly those which measure liquidity risk.

In this context, I am pleased to introduce "The Value of Liquidity" by Christopher Finger and Carlo Acerbi from RiskMetrics a paper designed to provide valuable insights into the notion of liquidity against the backdrop of the liquidity constraints faced by asset managers. The framework articulates key areas of consideration for portfolio managers to better understand and manage liquidity risk.

We trust you will find this paper both insightful and thought-provoking and look forward to your comments and feedback.

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Introduction

While liquidity–both too much and too little–has arguably been central to most financial crises, a concrete definition remains elusive. As a result, it is not surprising that measuring, managing and controlling liquidity is still a challenge. This paper endeavours to describe the various notions of liquidity, and then introduces a new framework under which liquidity can be valued and managed, while reflecting the specific liquidity needs of the institution in question. We then present an example portfolio, and characterise the nature of the results afforded by the model.

Defining liquidity

Part of what makes liquidity an elusive concept to model is that it takes on many forms, making the definition of one's "liquidity problem" a less than trivial task. Nonetheless, we begin by distinguishing two classic notions of liquidity: funding liquidity and asset (or market) liquidity.

Funding liquidity refers to the ability of an institution to raise funds in order to support its normal business activities. Simply put, it is the ability of an institution to borrow money. For banks, liquidity comes from the deposit base, from short and long-term debt in the capital markets, from committed credit lines from other banks and from short-term collateralised borrowing, such as repurchase agreements. Liquidity risk, consequently, derives from the potential depletion of these sources of funding. For example, depositors withdraw their funds, capital markets do not support further issuance, or lenders are unwilling to roll over short-term repurchase agreements. To control these risks, the Basel Committee has proposed two funding ratios. The first is a ratio of very high quality funding to the estimated cash needs in a severe one month stress scenario and the second is a ratio of available to required stable long-term funding.

In a fund management context, funding liquidity comes in slightly different guises. One element of funding comes from the investors themselves; the risk being that investors redeem in greater numbers or more quickly than the funds' assets can support. Indeed, just as banks may suffer a "run" when their depositors withdraw quickly, a fund can suffer adverse shocks to its NAV in trying to meet heightened redemptions. The case of the Reserve Fund in 2008 now serves as a chilling reminder of this. A second element comes from margin or other transaction level financing, which is typically used to achieve leverage on behalf of the investors.

Asset liquidity, on the other hand, relates to the depth of financial markets and the ease with which a security or portfolio may be converted to cash. Under most circumstances, a large cap equity or a large, widely held bond issue may be sold relatively quickly and large orders are likely to attract roughly the same price as small ones. For more lightly traded securities, the market may support only relatively small trades, or large trades may only be possible at a significantly discounted price. Of course, markets are unpredictable, leading to the asset liquidity risk that a formerly deep market suddenly becomes shallow.

While it is important to distinguish the two basic notions of liquidity and liquidity risk, it is equally important to recognise that they are closely linked. Heavy redemptions (funding liquidity risk) at an inopportune time may force a fund manager to sell otherwise healthy securities into a thinning market (asset liquidity risk), realising a loss that would otherwise not have been necessary. Likewise, the market for a bond, or even an entire class of bonds (as in the case of structured finance in 2008) may dry up (asset liquidity), making those bonds less attractive, or altogether useless as collateral for short-term borrowing (funding liquidity).

Based on this simple discussion, two problems become apparent. First, while we may have succeeded in defining liquidity conceptually, we still have not quantified its value or risk. Second, we cannot address the two types of liquidity in isolation. Endogenous effects–the funding needs of a bank or investment fund–drive exposure to exogenous risks–the depth or thinness of financial markets. As a result, a formalism is required that both prices liquidity and acknowledges that firm specific constraints play a significant role in determining liquidity risks.

Introducing the approach

To align these concepts, we present an approach that values portfolios based on the exogenous liquidity of the portfolio constituents and the endogenous constraints to which the portfolio owner is subject. In order to motivate the valuation approach, we consider two extremes.

The first extreme is where the portfolio owner has no constraints, liquidity or otherwise. In other words, there are no circumstances under which the owner would be forced to sell large or even small positions. Thus, the investor's holdings are not exposed to the depth (or lack thereof) of the markets, nor to changes therein. In this case, it is prudent to value the portfolio according to the best available bid (or ask) prices, that is, according to standard mark-to-market.

At the other extreme is an investor who faces the prospect of having to definitively liquidate his portfolio within some short time frame. It would be irresponsible to value this portfolio according to the best market quotes, knowing that the investor will shortly be liquidating, and likely not realising these best prices. Rather, the investor should value the portfolio according to the expected proceeds from the forthcoming liquidation. This valuation scheme is referred to as *mark-to-exit* (or mark-to-liquidation). We can say with certainty that the mark-to-exit value for a portfolio cannot exceed its mark-to-market value.

Realistically, the portfolio owner will be subject to some liquidity constraints, meaning that the mark-to-market view gives an overly optimistic view of valuation. At the same time, those constraints are not likely to always require immediate liquidation. The mark-to-exit value is thus, at best, an interesting stress scenario, but as a valuation policy it overstates the portfolio's exposure to liquidity concerns. We propose a valuation framework that fits between the two extremes and more accurately reflects the investor's actual constraints.

The first element in the valuation framework is information about the exogenous liquidity of the portfolio constituents. Beyond simply the best bid or offer in the market, we require information (or at least a hypothesis) for the price we can expect to realise for transactions of any given size. From a technical perspective, there are a variety of ways to express such information. Our approach utilises marginal supply-demand curves (MSDCs). In the middle of the curves are the best bid and offer prices–the prices we assume we can realise for small transactions–and further out on the curves is information about the price at which we could liquidate our entire holding. This is considered exogenous information, in that it is a property of the market itself, and every investor faces the same MSDC for a given security. With the MSDCs in hand, we can calculate the two extreme valuations: mark-to-market and mark-to-exit.

The second element is a new concept: *the liquidity policy* (LP). The LP accounts for the endogenous constraints to which a particular portfolio owner is subject. A simple LP might be "Be prepared to raise 1M in cash within one week's time." We refer to an LP of this form as a pure cash policy. It is important to note that the LP is not intended to impose that the portfolio always holds 1M in cash; rather, it is meant to convey that the portfolio manager must be at all times prepared to meet a 1M cash demand within a short time frame. This scenario might apply to a fund manager who has committed to meet a certain expected level of redemptions, or to a bank that must be prepared to cover for depositor withdrawals or the inability to roll over some amount of funding.

But generally, the fund manager will not face full redemption, nor will the bank face a catastrophic run or liquidity crisis. Even after raising the required cash, there is still a portfolio to manage, investment guidelines to meet and business to conduct. As a result, we cannot expect to raise the required 1M by any means. Rather, we must raise the 1M while

maintaining a desirable portfolio structure. A more realistic LP therefore includes additional constraints (e.g., "Be prepared to raise 1M in cash while maintaining the desired sector allocations and limiting risk to an acceptable level."). This can be further extended to require that specific hedge ratios or position offsets be maintained as well.

With the two elements in place–security-level exogenous MSDCs and the endogenous liquidity policy–the liquidity-adjusted value of the portfolio can be defined. If the portfolio already satisfies the LP–that is, it holds 1M in cash and complies with the other constraints–then its value is simply its mark-to-market. If the LP is not currently satisfied, then it is necessary to calculate the cost of bringing the portfolio into compliance. There will be multiple ways to do this, each entailing a different cost, depending on the MSDCs and precisely how much of each security is to be sold. Across these different strategies, we identify the most efficient one–the one that achieves the LP at the lowest possible liquidity cost. The *mark-to-liquidity* value of the portfolio then is the mark-to-market less the optimal cost of achieving the LP. This optimal cost is referred to as the portfolio's *liquidity impact*.

Again, we are not imposing the constraint that the portfolio manager actually performs the trades that achieve the LP: the manager simply needs to be prepared to do so. In this respect, the approach is very similar to a fund manager who commits to provide liquidity to the fund's investors: he does not always carry cash sufficient to meet all possible future outflows, but does commit to raise sufficient cash to meet outflows as they arise. The mark-to-liquidity framework provides us with the implicit cost of this commitment.

Before proceeding to an example of the framework, we make one important technical observation. The definition of the mark-to-liquidity value involves an optimisation: the discovery of the best way to achieve the LP. As with any optimisation, there are two important questions. First, does the optimal solution exist, and second, is the search for the optimum practical. In this respect, as long as the MSDCs behave in a reasonable way (e.g., larger trades touch thinner markets and result in less favorable pricing), and subject to some technical constraints on the LP (none of which will prove restrictive in our treatments here), the optimisation problem is convex. While not necessarily related to the financial intuition behind the framework, this fact has the important implication that the optimum strategy exists, and moreover, that the search for this optimum is feasible, even with large portfolios and complex constraints.[1]

[1] See Acerbi and Scandolo (2008) for a detailed explanation of the mark-to-liquidity framework.

Case study

To illustrate some of the features of the mark-to-liquidity framework, consider a sample equity portfolio with the majority of the positions in large capitalisation (LC) stocks, and some portion in emerging market (EM) stocks (refer to Table 1). In this example, we consider versions of this same portfolio with different total size, while maintaining the relative allocations presented in the table.

The first step is to characterise the exogenous liquidity of the portfolio. To distinguish liquid from illiquid stocks, we examine a variety of liquidity indicators or proxies, such as the bid-offer spread, the average trading volume and the total shares outstanding. These indicators are also presented in Table 1. By any of these indicators, not surprisingly, the EM equities appear most illiquid. Approximately 16% of the portfolio lies in the more illiquid EM positions. But this does not translate into a quantitative statement of the economic meaning of these differences in apparent liquidity.

To quantify the exogenous liquidity, we estimate the *liquidation* cost for each position. We define this cost between the best mark-to-market (the entire position valued at the best bid available in the market) and the mark-to-exit (the expected proceeds from closing the entire position). To estimate the liquidation cost, we rely on the aforementioned MSDCs.

In the equity market, there is rich literature on market impact and the effect on a security's price due to a large sale. We draw on one study in particular, Almgren et al. (2005). Almgren et al. examine a large cross-section of US stocks, and show that the relationship between the price a trader can realise and the size of the position being traded depends on two categories of factors: security specific factors such as the total shares outstanding, the average daily trading volume, and the recent volatility and a number of universal coefficients, which Almgren et al estimate from their cross section of data. In the end, we have a distinct MSDC for each security in our portfolio. The MSDC for one of the stocks is presented in Figure 1. This figure tells us, for instance, that to sell 20,000 shares, we would hit prices between 114.9 and 114.75, with an average price between these two levels. We may view the market risk in this stock as the potential shifts in the curve up or down and liquidity risk as the potential changes in the shape of the curve.

With the MSDCs in hand, we can calculate the liquidation cost for each position in the portfolio. One important note is that the liquidation cost does not scale linearly with the position size: as a proportion of position size, there will be a greater cost to exit a large position than a small one on the same stock. This is illustrated in Figure 2. For a total portfolio size of 1M, all of the liquidation costs are modest, even for the illiquid stocks, and the overall liquidation cost is only 20bp. As the portfolio increases in size, assuming the same relative allocations, we experience the downward slope of the MSDCs, and suffer greater costs; for a total portfolio of 1B, the liquidation cost is very significant, at just under 15% of the value.

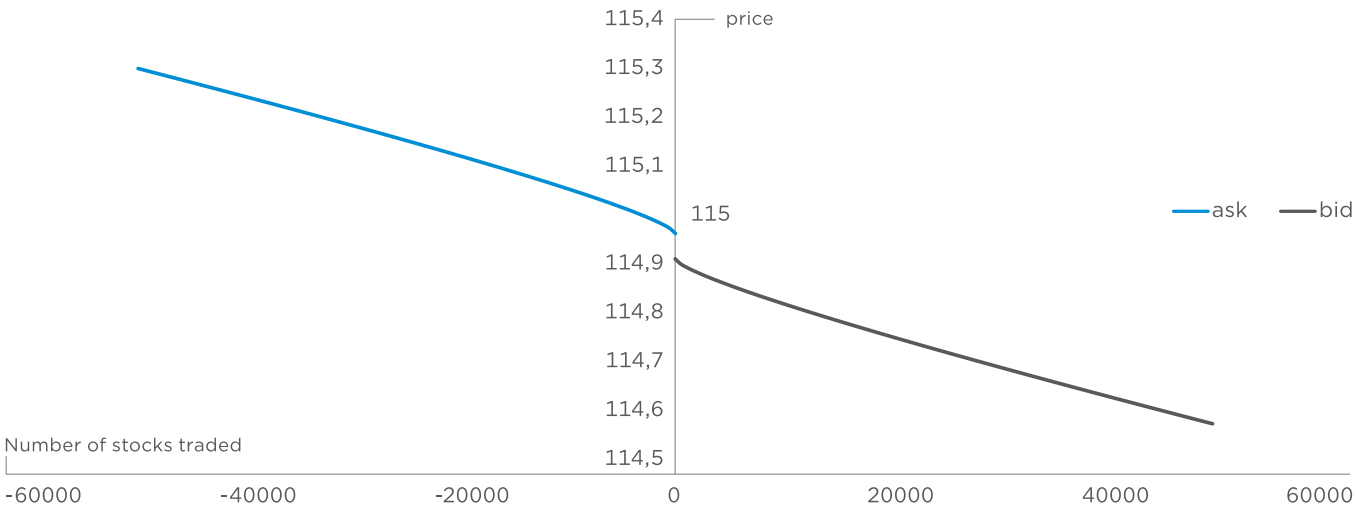
It is apparent that the valuation in the face of liquidity depends on the portfolio in a way that conventional mark-to-market does not. But as discussed previously, it is in most cases overly conservative to value the portfolio at the mark-to-exit, in that most investors are not subject to constraints that will actually require them to liquidate everything in a short time. This is where the liquidity policy (LP) enters.

As mentioned earlier, the LP is a set of constraints that the portfolio manager must always be prepared to satisfy. Assuming that the portfolio does not currently satisfy these constraints, the mark-to-liquidity value is calculated by finding the optimal way to satisfy the LP.

Table 1

	Weight	% bid-ask spread	Outstanding shares	Market cap	Average daily volume	Average daily turnover	Volume (120d)
Large cap stocks	7.53%	0.06%	2,063,073,000	35,959,362,390	20,268,490	0.98%	29.4%
	4.69%	0.01%	4,721,273,000	315,239,398,210	26,911,172	0.57%	18.1%
	4.04%	0.01%	526,251,100	92,088,679,989	12,049,916	2.29%	29.3%
	3.75%	0.02%	2,345,093,000	122,859,422,270	14,971,182	0.64%	20.8%
	3.48%	0.05%	5,524,000,000	117,550,720,000	58,714,996	1.06%	25.1%
	3.34%	0.02%	2,904,593,000	183,976,920,620	11,600,728	0.40%	14.3%
	3.32%	0.01%	2,008,353,000	148,136,117,280	11,068,801	0.55%	18.7%
	3.22%	0.03%	8,770,461,000	256,711,393,470	58,483,480	0.67%	21.1%
	4.82%	0.03%	1,939,515,000	65,381,050,650	12,511,876	0.65%	22.1%
	3.09%	0.02%	1,299,003,000	166,246,403,940	6,256,818	0.48%	17.8%
	3.09%	0.07%	1,821,688,000	25,558,282,640	20,741,216	1.14%	33.1%
	2.86%	0.02%	1,552,643,000	84,712,202,080	7,511,824	0.48%	15.4%
	2.09%	0.02%	1,486,838,000	76,884,392,980	10,415,717	0.70%	22.8%
	2.00%	0.10%	141,711,300	4,072,782,762	905,777	0.64%	27.9%
	1.81%	0.02%	2,751,927,000	176,591,155,590	11,543,674	0.42%	11.6%
	1.59%	0.04%	1,241,889,000	29,805,336,000	16,501,162	1.33%	27.1%
	1.56%	0.04%	135,071,200	3,826,567,096	2,230,985	1.65%	37.6%
	1.40%	0.03%	913,331,500	31,847,869,405	9,927,372	1.09%	22.9%
	1.25%	0.09%	49,804,910	1,708,308,413	339,286	0.68%	24.0%
	1.22%	0.06%	438,600,000	14,320,290,000	9,856,374	2.25%	35.3%
	1.24%	0.01%	446,800,000	31,494,932,000	4,094,013	0.92%	30.7%
	1.22%	0.03%	1,195,634,000	77,214,043,720	14,510,407	1.21%	31.0%
	1.20%	0.05%	90,274,800	5,003,932,164	274,979	0.30%	18.3%
	1.15%	0.04%	5,902,074,000	151,152,115,140	29,494,558	0.50%	15.8%
	1.15%	0.04%	811,956,000	66,401,761,680	5,524,251	0.68%	26.7%
	1.12%	0.06%	1,400,202,000	22,851,296,640	22,158,914	1.58%	25.6%
	1.10%	0.04%	31,559,070	3,628,030,687	507,083	1.61%	32.6%
	3.33%	0.07%	625,501,600	9,132,323,360	10,756,028	1.72%	44.3%
	6.67%	0.06%	237,356,600	3,773,969,940	5,634,384	2.37%	62.6%
	3.33%	0.03%	310,448,000	12,213,024,320	2,663,270	0.86%	23.3%
	1.67%	0.12%	798,521,000	13,199,552,130	3,396,161	0.43%	30.2%
Emerging market stocks	5.00%	1.74%	55,156,870	64,533,538	213,438	0.39%	81.2%
	3.33%	4.00%	2,633,500	17,117,750	9,000	0.34%	61.6%
	5.00%	0.67%	19,623,420	237,050,914	12,040	0.06%	54.3%
	1.67%	0.72%	19,280,060	53,984,168	23,954	0.12%	78.6%
	1.67%	0.49%	26,984,740	613,902,835	1,109,209	4.11%	84.5%

Figure 1 - Marginal supply-demand curve



To continue the example, we fix the overall value of the portfolio at 100M, the level at which the liquidation cost is roughly 11%. As a first case, we consider a cash liquidity policy: one that stipulates that the portfolio must be able to raise a certain amount of cash, but is not subject to any other restrictions. Clearly, the portfolio does not satisfy such a policy in its current state, so we need to transact in some of the portfolio holdings in order to raise this cash. The results of the cash LP example are reported in Table 3.

We first consider a cash LP where we must be prepared to raise 10M, or 10% of the portfolio, in cash. To raise this amount, the liquidity impact incurred is only 303, insignificant relative to the portfolio or even the cost of liquidating the entire portfolio. As the cash amount required is increased, there is a greater impact, but the level is still immaterial relative to the portfolio, and the mark-to-liquidity value is barely different from the mark-to-market.

This result is not surprising: the portfolio has ample liquidity in the form of the LC stocks and is not required to experience shallow markets even in raising 85M. Most of the liquidity impact is experienced by selling the EM stocks and these represent only 16% of the portfolio. There is a concerning effect though. Consider the Value-at-Risk (VaR) of the remaining portfolio, that is, what remains after the cash has been raised. As the portfolio raises more cash, its risk markedly increases and doubles by the time the cash reaches 85M. This is sensible, as the optimal way of raising the cash is to sell the most liquid stocks, which in our case are also the least volatile ones. The portfolio can achieve the cash policy at relatively little cost, but is completely transformed in the process from a diverse set of holdings to a concentrated set of positions in illiquid and volatile stocks.

These results bring us back to our earlier remarks about the portfolio not simply being a source of cash but requiring ongoing management. Thus, it is not realistic to only require that the portfolio be able to generate cash. Rather, the portfolio should be able to generate cash as required, while maintaining an investment profile that is suitable for the future. To continue this example, in addition to the cash constraints, we stipulate that the portfolio VaR be no greater than 7.5% (its original value recall is 7.08%) and that the positions in EM stocks sum to no greater than 20% (the original allocation to EM is 16%).

We now repeat the exercise, examining the effects of different levels of required cash and see that the liquidity impact is material. Please refer to Table 4. For example, if we require that the portfolio be able to generate 50M in cash, while complying with the risk and allocation constraints, then the liquidity impact is almost 2% of the portfolio. If the portfolio manager is committed to providing this level of potential liquidity, while maintaining the desired investment profile, the portfolio valuation should reflect that impact.

The explanation for this now material liquidation cost is straightforward. In order to stay within the risk and allocation limits, the portfolio manager cannot simply sell the most liquid stocks. Rather, he must sell at least some of the EM stocks and in so doing experience the impact of the steepest MSDCs in the portfolio.

Figure 2 - Liquidation cost (%)

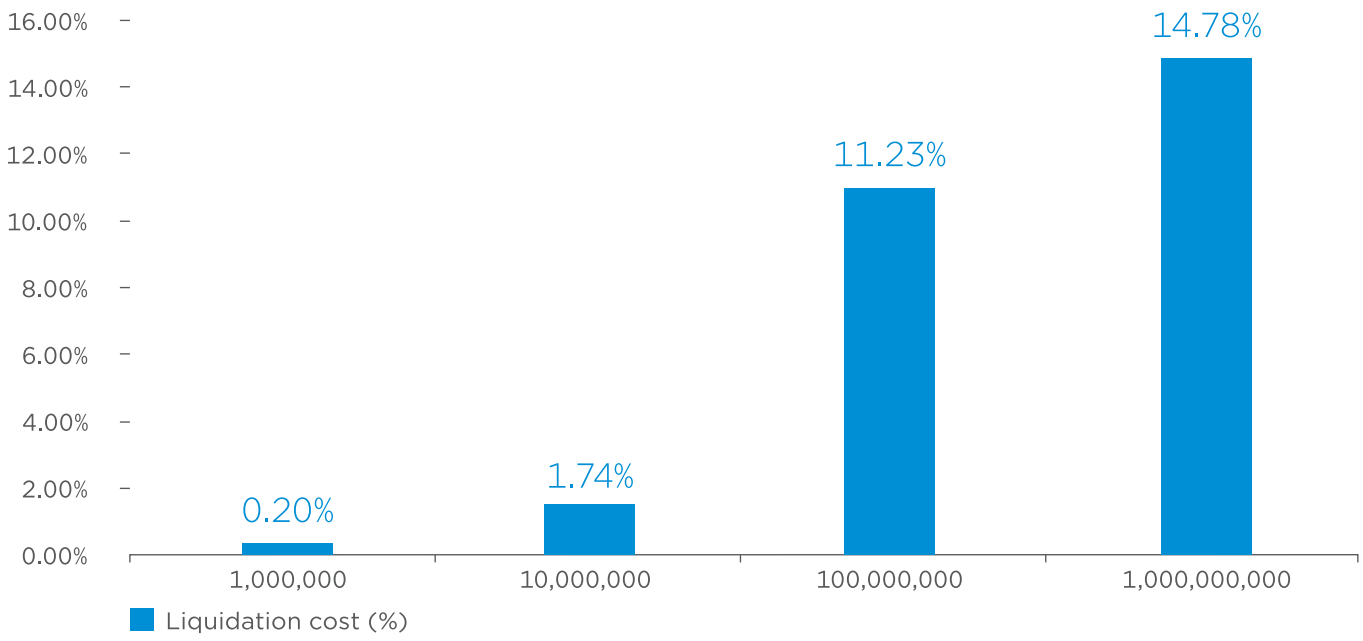


Table 3

Cash only LP

Cash limit	10,000,000	50,000,000	75,000,000	80,000,000	85,000,000
Mark-to-market	99,848,267	99,848,267	99,848,267	99,848,267	99,848,267
Mark-to-liquidity	99,847,964	99,843,832	99,830,741	99,821,612	99,806,320
Mark-to-exit	88,616,568	88,616,568	88,616,568	88,616,568	88,616,568
Liquidity impact	303	4,435	17,526	26,655	41,947
VaR %	7.39%	9.60%	12.50%	13.11%	14.23%

Table 4

Cash + VaR + linear LP

Cash limit	10,000,000	50,000,000	75,000,000	80,000,000	85,000,000
Mark-to-market	99,848,267	99,848,267	99,848,267	99,848,267	99,848,267
Mark-to-liquidity	99,847,602	97,867,301	92,029,258	90,779,706	89,524,001
Mark-to-exit	88,616,568	88,616,568	88,616,568	88,616,568	88,616,568
Liquidity impact	665	1,980,966	7,819,009	9,068,561	10,324,266
VaR %	7.40%	7.50%	7.50%	7.50%	7.50%

Applications of the framework

Perhaps the most obvious application of the mark-to-liquidity framework is not the valuation at all, but the set of transactions that arise from the optimisation process. In the fund management context, when redemptions actually occur, the framework provides guidance on what of the portfolio to sell, all the while adhering to the investment guidelines that will apply for the remaining portfolio. Similarly, if we were faced with the need to partially liquidate a margin portfolio to cover counterparty obligations, the framework would provide the most efficient liquidation strategy, possibly in this case without regard for the composition of the portfolio after liquidation.

Applied in this way, however, the mark-to-liquidity framework does not truly change investors' behavior in the face of liquidity constraints. The optimisation gives us a means to react more efficiently to the need to liquidate, but we are only reacting and not planning. This brings us back to the notion of liquidity policies and our emphasis that in all our examples, those policies began with the words "Be prepared".

By doing nothing more than stating the liquidity policy explicitly, we are already moving beyond the reactive posture to liquidity. The liquidity policy can act as a plan, or even more strongly, as a commitment for a portfolio. We acknowledge that the portfolio will be used to generate cash to meet investor redemptions, to pay traders, or to fund other operations. And rather than bearing the cost of these commitments when they arise, the mark-to-liquidity framework leads us to assess and value them beforehand. Acknowledging that liquidity is valuable, and then placing a specific value on it, has profound implications.

In a fund management setting, managers typically commit to providing liquidity to investors, subject to a certain notice period. The period may be a short as a single day (as for most mutual funds) or a matter of months, in the case of many hedge funds. In a narrow sense, more liquidity (meaning shorter notice periods) is positive for an investor; however, the fact that other investors might redeem as well is a cause for concern. What level of redemptions can a manager support before his ability to maintain a desirable investment profile is compromised, or he is forced to suspend further redemptions altogether? An investor with otherwise no need or desire to redeem may in fact choose to redeem because of the fear of other investors' actions. This dynamic can lead ultimately to the "run on the fund" scenario, with investors rushing away from the fund simply because they do not want to be last.

Through the lens of mark-to-liquidity, this dynamic is a result of the failure to place a value on the liquidity promised to the investors. The earliest investors to redeem are the ones that realise the benefit of the liquidity commitment, with the investors remaining left to bear the true liquidity cost. By estimating upfront the cost of providing liquidity it can then be assessed to all investors, regardless of when they redeem. This could take the form, for instance, of a NAV based on mark-to-liquidity using the fund's liquidity commitment and investment profile as the liquidity policy. Such a liquidity-adjusted NAV would diminish the incentive to redeem out of fear only and ultimately lead to a more stable investor base. Less controversial would be to maintain the current NAV policy, but for the fund manager to track the cost of the liquidity commitment, and to manage the portfolio in such a way as to limit the cost.

From valuation to risk

Remembering that the "V" in VaR stands for value, we can view risk in the context of mark-to-liquidity. It is by now common knowledge that while the classical VaR measures may provide useful indications of portfolio risk in liquid markets, they do not address risk in the presence of less than perfect market liquidity nor portfolio liquidity constraints. Thus far, the regulatory response to this–both in the banking sector (through the BIS) and in the fund management sector (primarily through UCITS)–has been to maintain the existing VaR applications, and then ask that institutions address the possibility of liquidity risk (as well as other previously neglected risks) separately through stress tests. Mark-to-liquidity has the potential to both expand the scope of VaR and to provide a framework for liquidity stress tests.

In a sense, we may view the failure of classical VaR to address liquidity as a result of its reliance on mark-to-market for valuation. A first step to address this is to apply the statistical tools from VaR to the portfolio's mark-to-liquidity value. In the simplest case, we can assume that the exogenous liquidity–taken as the shape of the MSDCs–is constant, while market risk–represented as the level of the MSDCs–evolves according to our VaR assumptions. This is far from a trivial model, in that even with static market liquidity, we already admit the possibility of interactions between market risk and liquidity. In our example portfolio, a significant market loss on one of our LC stocks may cause us to rely on the EM stocks for liquidity, forcing us to sell securities onto a steeper MSDC. A market move that would only impact the portfolio by 1% in mark-to-market terms could in this case impact the mark-to-liquidity by more. This interaction then magnifies the portfolio VaR.

This approach can be seen as reflecting the state of today's market liquidity in the VaR measure–already an important step forward. To address stressed market liquidity, we can shock the shapes of the MSDCs, defining a scenario where market depth decreases for all securities. Of course, such a scenario has no explicit effect on the portfolio mark-to-market, but does impact the mark-to-liquidity. So beyond assessing the cost of our liquidity commitments, we can examine the effect of a liquidity shock on this cost.

Ultimately, we may anticipate a model where we describe both the market and liquidity effects, and their interactions, statistically, and reflect all of these in the portfolio mark-to-liquidity. Such a model may be years away, but we should not let that frustrate us, nor distract us from the more immediate and practical applications above.

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