VOLATILITY AND CORRELATION ASSUMPTIONS

After near-term choppiness, long-run forecast remains stable

Grace Koo, Ph.D., *Quantitative Analyst and Portfolio Manager, Multi-Asset Solutions*
Xiao Xiao, CFA, *Quantitative Analyst, Multi-Asset Solutions*
John C. Manley, *Global Market Strategist, Global Market Insights Strategy*

IN BRIEF

- Despite a roller-coaster ride for markets and economies in 2020, our volatility and correlation forecasts are stable year-over-year because previous years' assumptions already factored in short-term disruptions.
- Unprecedented Federal Reserve actions and enormous fiscal support will likely keep U.S. fixed income and credit market volatility depressed in the next few years before rising to our long-run forecasts.
- In equities, we expect volatilities to return toward long-run historical levels after the uncertainties around the new U.S. administration and the pandemic recovery have receded over the coming months and quarters.
- In *ex ante* Sharpe ratio terms, U.S. government bonds and equities deteriorate again this year over our forecast horizon. Bonds' near-term Sharpe ratio, however, is likely better as they benefit from dampened volatility over the next few years. Our preference, in risk-adjusted terms, for extended credit and alternatives – especially real assets – continues to strengthen.
- Our case study explores a framework for adding liquidity considerations to portfolio construction. We find that it helps create a more balanced and diversified portfolio with improved liquidity profiles while minimally affecting the expected risk and return.
- A structured way of incorporating liquidity metrics offers investors an additional lens when allocating to less liquid assets such as extended credit and alternative assets – a likely direction of travel, given the need to expand investment opportunity sets to achieve an acceptable return.

OUR LONG-TERM FORECASTS REMAIN STABLE DESPITE 2020'S ROLLER COASTER

The year 2020 will be difficult to forget. Although we highlighted in last year's edition of our Long-Term Capital Market Assumptions (LTCMAs) the late-cycle dynamics that made us focus on limiting downside risk and providing a ballast to risk-taking, the timing and speed of 2020's pandemic-led recession were surprising. U.S. large cap equities experienced a 3 standard deviation negative shock in one month (**EXHIBIT 1**). The commonly referenced fear gauge – the Volatility Index (VIX), measuring the implied option volatility of the S&P 500 – hit a new all-time high in March.

But as fast as the pandemic hit global markets, the rebound velocity has been equally exceptional. Central banks and policymakers, keen to stop the free fall, rolled out an unprecedented amount of fiscal and monetary policy support beginning March 2020. As a result, financial markets recovered rapidly, well ahead of macroeconomic data, as investors looked forward to an eventual economic recovery in the coming years.

Despite the pandemic's enormous disruption to economic fundamentals and drastic effect on asset prices, our volatility and correlation assumptions are remarkably stable year-over-year. Past LTCMAs had already factored in stress periods over the forecast horizon, and by virtue of our methodology, the forward-looking forecasts are relatively unchanged year-over-year. The continuation of central bank intervention that we had anticipated also provides stability, keeping our forecasts well anchored with a relatively low level of volatility, despite high levels of uncertainty.

One thing that remains unclear is the price that economies and markets may pay for unconventional central bank actions. This heightened uncertainty is not directly observable in our core forecasts. That is because our core expectation embeds stability due to expected central bank intervention. We do, however, see a wider than normal range of potential alternative outcomes. We acknowledge that near-term uncertainty surrounding the economic recovery and policies may keep markets choppy into year-end 2020. While not impacting our long-term forecasts in the 2021 LTCMAs, this volatility may affect short-term asset pricing.

MAKING OUR ESTIMATES MORE RELEVANT

For this year's LTCMA forecasts, we continue to expand the data window, or lookback period, an important anchor for our forecasting process. Compared with a simple rolling-window estimate,[1] our methodology emphasizes making the data we use more representative and relevant for our forecasts.[2]

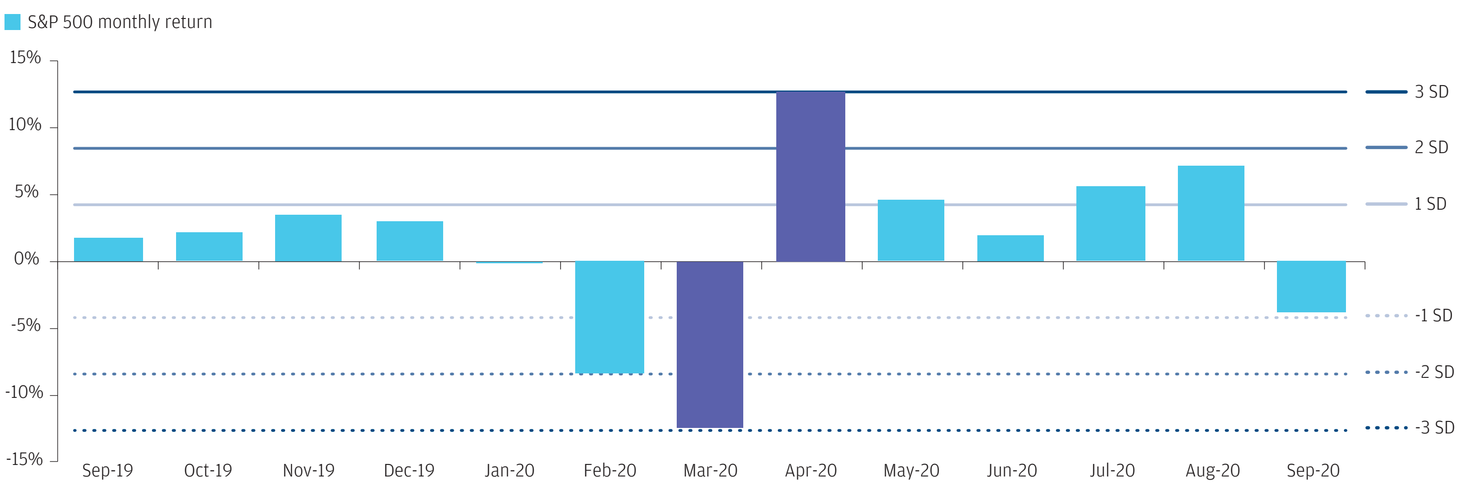
To incorporate a more typical economic downturn – in addition to the atypical one of 2020 – we continue to include the 2007–09 period in our analysis. This lengthens our data window by one year, from 13 years (2006–19 in last year's LTCMAs) to 14 years (2006–20 this year). We continue to incorporate forward-looking expectations over the forecast horizon, including the probability of stressed and

[1] A rolling-window volatility estimate uses a fixed time period, or window, of data while varying the data input as time passes.

[2] For more on how we incorporate relevance into our estimation process, please see Grace Koo, Xiao Xiao and Ivan Chan, "Volatility and correlation methodology," *2020 Long-Term Capital Market Assumptions*, J.P. Morgan Asset Management, November 2019.

Extreme moves: Monthly S&P 500 returns posted a 3 standard deviation loss, then dramatically rebounded the following month

EXHIBIT 1: YEAR-TO-DATE EXPERIENCE VS. HISTORICAL DISTRIBUTION OF U.S. LARGE CAP STOCK RETURNS



Source: Bloomberg, J.P. Morgan Asset Management; data as of September 30, 2020. For illustrative purposes only.

high volatility periods, which remains unchanged at 15%,[3] typical for the modern economy since the 1980s.

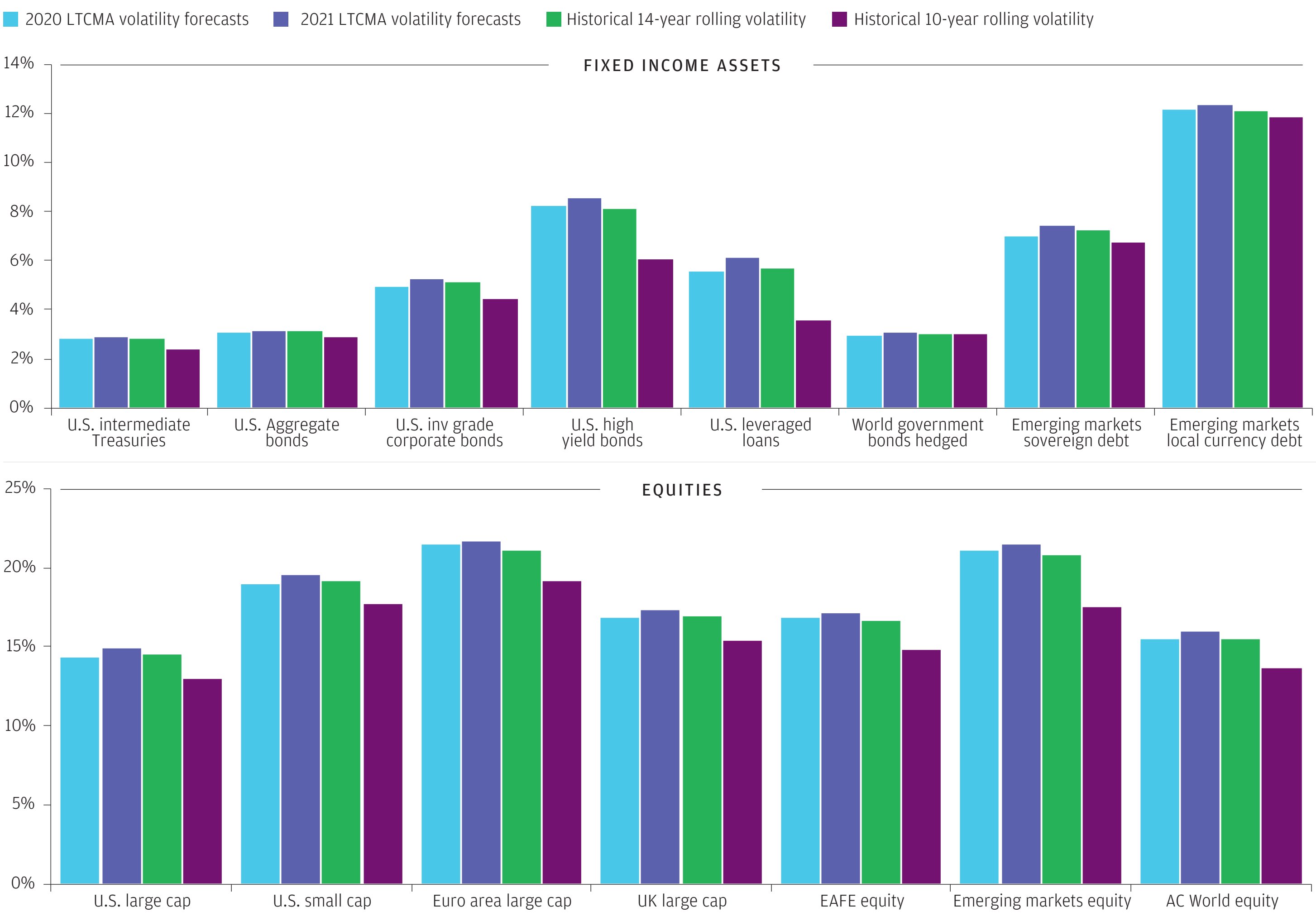
EXHIBIT 2 shows our 2021 LTCMA volatility forecasts for major asset classes relative to history: vs. last year, over the past 10 years and over our 14-year sample period. The chart highlights the need to continue expanding the data window, as 10-year lookback periods may underestimate the forward-looking risk (volatility) over a full cycle. This year's dramatic financial market events provided another instance of an economic downturn within our analysis period, leading to a similar output from the 14-year estimation window and our forecast. Since our forward-looking adjustments (in place for a number of years) already reflected and incorporated the likelihood of another recession in last year's forecasts, the year-over-year change in risk estimates is minimal.

We continue to incorporate into our estimates expected structural changes to volatility relative to history. A few years back, we noted a downward bias in short-duration government bond volatility compared with long-run behavior. We attributed it to global central bank intervention. At the time, quantitative easing was expected to be unwound gradually, within the LTCMAs' 10- to 15-year time frame, so we expected short-duration government bond volatility to revert to its long-term mean. However, the pandemic-driven fiscal and monetary policy support now leads us to expect short-term rates' dampened volatility may persist, and therefore we removed an adjustment made last year, given the current backdrop. We anticipate policy rates to be on hold for several years, followed by slow, steady normalization before reaching our equilibrium yields.

[3] In the estimation process, a 15% weight is the total weight applied to the data points associated with stressed periods. These weights are evenly spread across all months during recessions (as determined by NBER in the data sample period), which are December 2008-June 2009 and February-April 2020 (the latter based on our expectation of NBER's likely classification).

Forecasts demonstrate stability, as prior years incorporated recession expectations

EXHIBIT 2: YEAR-OVER-YEAR COMPARISON, LTCMA VOLATILITY FORECASTS



Source: Bloomberg, J.P. Morgan Asset Management; data as of September 30, 2020. For illustrative purposes only.

In U.S. credit markets, unprecedented Federal Reserve activity alongside enormous fiscal support will likely keep volatility depressed over the next few years, close to the levels observed today. Over the long run, however, lowered credit quality in the U.S. corporate bond market should generate higher volatility compared with the past 15 years. We are not anticipating further deterioration of average corporate bond credit quality but rather adjusting to the existing low quality: The majority of U.S. investment grade bond market issuance is now BBB rated, increasing risk relative to past years, when credit quality was generally higher. A similar decline in average credit quality, with similar implications, can be observed in Europe.

In equities, we expect volatility to stay in line with long-run historical levels. Our volatility forecasts for alternative assets are also little changed, with our leverage assumptions staying relatively stable. We retain the view that leverage in real estate and REITs is likely to stay below the last cycle's peaks. This results in lower forecasted volatility vs. recent history.

In *ex ante* Sharpe ratio terms, we see another year of deterioration for both U.S. government bonds and equities over the forecast horizon. As highlighted in the 2021 LTCMA Executive Summary, the traditional stock-bond frontier, built by varying allocation between stocks and bonds, is unlikely to generate the level of return required by many investors. To harvest higher return, investors will no longer simply be able to allocate to equities to obtain the equity risk premium. They will also need to allocate to an expanded opportunity set.

Among the assets for which we produce forecasts, the best risk-adjusted returns lie within extended credit, especially emerging market debt and leveraged loans, and within alternative assets, especially real assets. We continue to caution investors to consider asset class characteristics beyond the return and volatility dimensions. Many of these assets have fat-tail risk, along with liquidity risk. To help investors better understand the portfolio implications of this edition of LTCMAs, see Grace Koo, Sorca Kelly-Scholte et al., "Portfolio implications: Actionable insights for diversifying portfolios amid extended valuations."

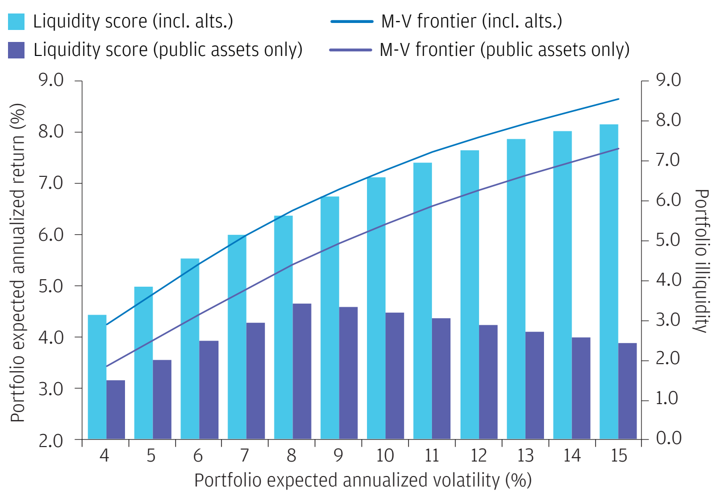
SPECIAL TOPIC: INCORPORATING LIQUIDITY CONSIDERATIONS INTO PORTFOLIO DESIGN

To achieve an acceptable return in the low return world of this year's LTCMAs, investors will likely move further away from a simple mix of equities and government bonds toward credit (for publicly traded assets) and/or alternatives (when possible),[4] especially for investors with moderate to high risk tolerance. While potentially improving performance, this direction of travel will inherently increase portfolio illiquidity **(EXHIBIT 3**).

Investors lacking an appropriate framework for investing in alternative assets might limit their allocation to less liquid assets. Others might opt for a subjectively designed mixture of alternative and publicly traded assets, accompanied by mean-variance optimizations weighing risk against expected returns, to meet their risk-return profiles. For more insights on alternative assets and their growing role in portfolios, see the alternatives thematic section and the Alternative Assets Assumptions section of this year's LTCMAs.[5]

Including alternative assets in portfolios should improve performance, yet liquidity is a concern

EXHIBIT 3: MEAN-VARIANCE EFFICIENT FRONTIER



Source: J.P. Morgan Asset Management; data as of September 30, 2020. For illustrative purposes only.

[4] For more on our alternatives framework, see Anthony Werley et al., "Alternative Assets Assumptions: A welcome source of alpha, income and diversification," *2021 Long-Term Capital Market Assumptions*, J.P. Morgan Asset Management, November 2020.

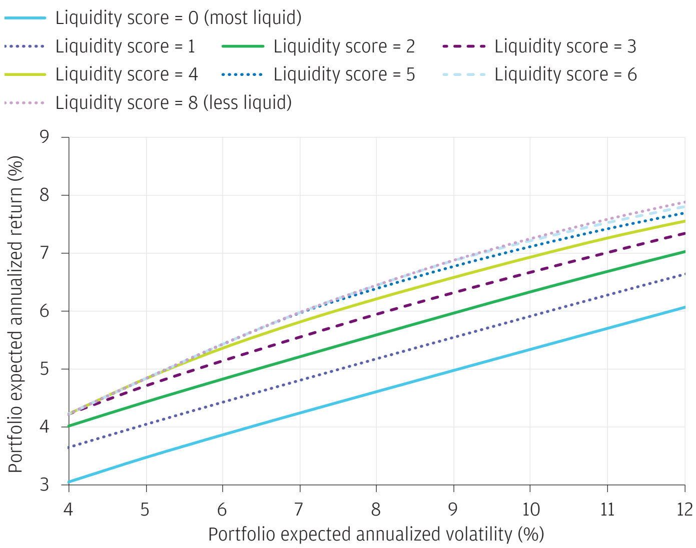
[5] Anthony Werley et al., "Alternatives: From optional to essential," and Werley et al., "Alternative Assets Assumptions," *2021 Long-Term Capital Market Assumptions*, J.P. Morgan Asset Management, November 2020.

A FRAMEWORK FOR INCORPORATING ASSET LIQUIDITY INTO PORTFOLIO CONSTRUCTION

We propose here a framework to help determine the trade-off between higher risk-adjusted returns and a portfolio's liquidity profile. This framework is helpful in directly incorporating liquidity considerations into portfolio construction – moving beyond the commonly used mean-variance frontier to create a mean-variance-liquidity frontier (**EXHIBIT 4**).

Higher expected returns are required to compensate for increased risk as well as illiquidity

EXHIBIT 4: MEAN-VARIANCE-LIQUIDITY FRONTIER



Source: J.P. Morgan Asset Management; data as of September 30, 2020. For illustrative purposes only.

To do this, we need a way to score or rank assets in terms of their relative liquidity. We considered the ease of executing large trades in a short time period, the price impact, any settlement delay, investment lockup periods, redemption notice periods and the availability of a secondary market, among other things. The main criterion was ease in liquidating the holding and having the capital returned. At the current stage, our scoring – from zero for the most liquid assets (such as U.S. large cap equities and major developed market government bonds) to 9 for the most illiquid (such as private equity) – is subjective.[6] Within publicly traded assets, we see a range of liquidity scores, from zero to 4 (e.g., extended credit markets such as high yield bonds and emerging market sovereign debt have a liquidity score around 3–4). Alternative assets tend to score 5 or higher (**EXHIBIT 5**). We acknowledge the challenges of capturing a complex topic in an overly simplified setup but consider it a step in the right direction.

There are multiple ways to incorporate these liquidity scores into the portfolio optimization process. We explore two of them in this section:

(a) **Applying liquidity as a constraint**: Optimizing the standard mean-variance objective function by adding a portfolio liquidity constraint that imposes a limit on the level of illiquidity the portfolio is allowed.[7]

(b) **Applying a penalty function**: Adding an individual asset's liquidity score directly into the mean-variance objective function as a penalty. We set up a quadratic penalty function, as liquidity is nonlinear in nature and better captured, in our opinion, in a nonlinear way.

APPROACH (a) is to impose an additional constraint in the mean-variance optimization problem:

$$\max\ w'\mu - \tfrac{1}{2}w'\Sigma w \qquad \text{(1a)}$$

$$s.t.\ \sqrt{w'\Sigma w} = \widehat{\sigma_p} \qquad \text{(1b)}$$

$$0 \le w \le 1 \qquad \text{(1c)}$$

$$Aw \le b \qquad \text{(1d)}$$

$$Aeq \cdot w = beq \qquad \text{(1e)}$$

$$w'l \le \widehat{l_p} \qquad \text{(1f)}$$

Here, $\boldsymbol{w}$ is the vector of asset weights to be optimized, μ is the vector of expected returns, Σ is the covariance matrix from our LTCMAs, $\widehat{\sigma_p}$ is the target portfolio risk, l is the vector of liquidity scores, and $\widehat{l_p}$ is the minimum liquidity threshold. The objective function (1a) is the standard mean-variance optimization objective, which maximizes portfolio return while penalizing portfolio risks. (1f) is the additional liquidity constraint imposed on traditional mean-variance optimization. Exhibit 5 displays the detailed optimization setup.[8]

[6] At this stage, the magnitude of each liquidity score does not have a direct economic meaning. It may be useful, as a reference, to associate scores with commonly owned assets. The scores are most useful when investors are comparing different portfolios. As we continue to refine this methodology, we will look to make these liquidity scores more objective and quantifiable.

[7] The portfolio liquidity score is the weighted sum of individual asset liquidity scores.

[8] Other constraints not listed: Sum of all positions equals 100%.

Selected assets, their constraints and liquidity scores in both optimization approaches we explored

EXHIBIT 5: OPTIMIZATION WITH LIQUIDITY CONSIDERATIONS SETUP

Group	Asset	Group constraint	Asset-to-group ratio constraint	Liquidity score
Cash	U.S. cash	0-100%		0
Fixed income	U.S. intermediate Treasuries	0-100%		0
	U.S. long Treasuries			0
	U.S. inv grade corporate bonds			1
	U.S. high yield bonds		U.S. high yield bonds + emerging markets debt <= 50% total fixed income	3
	Emerging markets sovereign debt			4
Equities	U.S. large cap	25-100%	25%–100% total equity	0
	EAFE equity		12.5%–100% total equity	0
	Emerging markets equity		5%–100% total equity	2
Alternatives	Diversified hedge funds	0-100%		4
	U.S. core real estate			5
	European ex-UK core real estate			5
	Asia-Pacific core real estate			5
	Global core infrastructure			6
	Direct lending			8
	Private equity			9

Source: J.P. Morgan Asset Management; as of September 30, 2020. For illustrative purposes only.

APPROACH (b) is another method of incorporating liquidity into the mean-variance portfolio optimization process, using the liquidity metric in the objective function:

$$\max w'\mu - \tfrac{1}{2} w'\Sigma w - \gamma\, w'\, diag(\mathrm{l}) w \qquad \text{(2a)}$$

$$s.t.\ \sqrt{w'\,\Sigma w} = \widehat{\sigma_p} \qquad \text{(2b)}$$

$$0 \le w \le 1 \qquad \text{(2c)}$$

$$Aw \le b \qquad \text{(2d)}$$

$$Aeq \cdot w = beq \qquad \text{(2e)}$$

Here, γ is the illiquidity tolerance parameter and $diag(l)$ is the square matrix, with the diagonal being the liquidity score vector. The objective function (2a) has an additional penalty on portfolio illiquidity compared with traditional mean-variance optimization.

Our portfolio construction framework has the flexibility to handle different liquidity inputs by users and incorporate varying constraints (on an individual asset level or as group constraints by asset type or liquidity profile). In the discussions below, we intentionally keep the setup relatively unconstrained to highlight these dynamics.

The optimization results and portfolio analytics can be found in **EXHIBIT 6**. We set the portfolio risk target (annualized) to be 7%[9] for both optimizations to represent a typical moderate risk portfolio. We also construct a reference portfolio for comparison. Within the reference portfolio, we fixed the relative weights among the alternative assets to ensure a diversified basket of alternatives based on qualitative considerations.[10] When compared with the reference portfolio, we find that utilizing liquidity scores provides comparable expected portfolio risk and return but with improved liquidity profiles. There are pros and cons for each of the optimizations.

For approach (a):

- Applying portfolio-level liquidity constraints helps control the total weighting of alternatives and portfolio liquidity. However, the optimized portfolio often hits so-called corner solutions – where the “best” solution is achieved based on brute-force boundary conditions due to a reduced feasible region.[11]
- The asset inclusion or exclusion in the optimized portfolio usually follows a preference order based on the risk-return profile, diversification benefits and liquidity score of individual assets.

[9] The 7% figure is based on a 50/50 stock-bond mix, utilizing the 2021 LTCMAs.

[10] The alternative asset mix and weights are constructed by J.P. Morgan Asset Management internal teams for a balanced alternative allocation, using a variety of lenses, such as mean-variance efficiency, risk parity, market size of the assets, manager view, etc., in both a qualitative and a quantitative manner.

[11] A feasible region, in an optimization, is a set of candidate solutions to the optimization problem that satisfy the constraints. A feasible region tends to be reduced with an increased number of constraints.

- Calibration of the liquidity threshold is arbitrary, and results are sensitive to the choice of this threshold: If the threshold is too relaxed, the optimized portfolio will overload with the inclusion of alternatives; if too tight, the optimized portfolio will overload with the inclusion of credit.
- Sharpe ratio might be compromised slightly.

For approach (b):

- Applying a liquidity penalty in the objective function (2a) helps to control total alternatives weights and portfolio liquidity.
- Penalties on illiquidity are applied across all assets at the same time in the optimization objective; therefore, there is no reduced feasible region problem. As a result, optimized results are more diverse and intuitive.
- Optimization is not overly sensitive to the illiquidity tolerance parameter value.
- Sharpe ratio is comparable to the reference portfolio's.

Many aspects of our analysis can be extended and would benefit from further research. In particular, a more precise and economical measure would improve the usability of the framework and lead to better risk-return-liquidity efficient portfolios.

Despite its simplicity, the framework demonstrates the importance of incorporating key risk aspects into portfolio designs over and beyond the two dimensions of return and volatility. Liquidity is one of the key characteristics on which we believe investors should maintain a keen focus when expanding their investment opportunity set. Our attempt to provide a generalized framework that systematically takes extended liquidity characteristics into account helps preserve portfolio efficiency. Like any quantitative framework, the proposed mean-variance-liquidity approach does not substitute for expertise in asset allocation and the need to adapt to wider characteristics than return, volatility and liquidity. This will likely be of increasing importance as the world recovers from the pandemic and moves beyond the disruption that has ensued, and as investors embrace new opportunities outside of traditional markets.

Portfolio optimizations incorporating liquidity considerations provide risk-return profiles comparable to a reference portfolio's, but with better-controlled liquidity profiles

EXHIBIT 6: PORTFOLIO COMPARISON: REFERENCE, LIQUIDITY CONSTRAINED AND LIQUIDITY PENALTY

	Group	Reference portfolio	Liquidity constraint	Liquidity penalty
Portfolio statistics	Portfolio risk target	7.0%	7.0%	7.0%
	Portfolio expected return	5.1%	4.9%	5.1%
	Portfolio Sharpe ratio	0.57	0.54	0.57
	Portfolio liquidity score	2.57	1.55	2.14
Asset allocation (%)	U.S. intermediate Treasuries	18.1%	26.1%	23.8%
	U.S. long Treasuries	14.2%	10.7%	10.9%
	U.S. inv grade corporate bonds	0.0%	0.0%	0.0%
	U.S. high yield bonds	0.0%	0.0%	4.0%
	Emerging markets sovereign debt	12.7%	0.0%	4.5%
	U.S. large cap	6.3%	8.3%	6.8%
	EAFE equity	17.5%	23.3%	18.6%
	Emerging markets equity	1.3%	1.7%	1.7%
	Private equity	6.0%	0.0%	3.2%
	U.S. core real estate	3.0%	19.2%	6.1%
	European ex-UK core real estate	1.8%	8.4%	5.3%
	Asia-Pacific core real estate	1.2%	0.0%	5.0%
	Global core infrastructure	6.0%	2.2%	5.1%
	Diversified hedge funds	3.0%	0.0%	0.0%
	Direct lending	9.0%	0.0%	4.9%
Total allocation (%)	Total fixed income	45.0%	36.8%	43.2%
	Total equities	25.0%	33.3%	27.2%
	Total alternatives	30.0%	29.9%	29.7%

Source: J.P. Morgan Asset Management; data as of September 30, 2020. For illustrative purposes only.

LET'S SOLVE IT®

LV–JPM52800 | 11/20 | US | 0903c02a82724c2b