CLIFFWATER LLC

Forecasting Risk for Illiquid Asset Classes

October 2019

Allocators and investors struggle with measurements of risk for illiquid asset classes, believing that standard deviation and correlation may be understated due to a lower pricing frequency (quarterly instead of daily) and possible smoothing of valuations.

Statistical methods to "unsmooth" illiquid asset returns are available. We show that risk measures for private equity, private real estate, and private debt are higher when adjusted for smoothing, but in some cases not nearly as high as most allocators believe based upon a popular survey of capital market assumptions.[1] If correct, investors may have a suboptimal underweight to illiquid assets.

Background

Fifty years after the introduction of Markowitz-inspired covariance-based portfolio optimization models, allocators still struggle with how best to integrate illiquid (private) assets where the absence of market-based valuation can hobble risk estimation. Standard asset allocation protocol involves risk calculations based upon monthly index returns as input to a covariance matrix that, together with return estimates, forms an efficient frontier. Absent monthly index returns, risk estimation for illiquid assets requires a workaround that yields risk estimates that conform as closely as possible to those traditionally produced for liquid asset classes.

Allocators have commonly used two methods to estimate private asset risk, both of which suffer significant deficiencies. The *constraint method* directly calculates risk[2] from available periodic returns reported by private fund universes, such as those provided by Cambridge, Pitchbook, Burgiss, or NCREIF. These periodic returns are based upon "fair value" accounting methods for valuing private assets and thereby the value of LP interests in private funds. Fair value accounting, despite best efforts, tends to understate change in valuation, thus producing a "smoothing" effect on returns. Also, for many private funds an outside independent valuation is only completed annually and consequently any intermediate return volatility can be disguised. The magnitude of volatility dampening is thus influenced by the valuation policy of the private fund. Allocators understand that smoothed return series likely understate both private asset volatility and correlation, thereby producing an overweight to private assets in a standard portfolio optimization. To correct for this error, allocation limits (constraints) are imposed on private assets in the optimization or efficient frontier calculation. This practice makes for an unsatisfying solution as allocations to private assets become a byproduct of subjective constraints chosen by the allocator.

[1] *Survey of Capital Market Assumptions*, 2019 Edition, Horizon Actuarial Services, LLC.
[2] Risk measures include both standard deviation of return and correlation across asset classes.

A second *public equivalent method* seeks to put private asset risk on the same footing as public asset classes by identifying and using risk estimates of market indices that are the nearest public equivalent to the private asset. These public equivalent indices may undergo adjustment based upon perceived differences in the public and private asset classes. For example, private real estate risk could be proxied by historical risk calculated from an index of publicly traded REITs; performing private debt could be proxied by historical risk calculated from an index of broadly syndicated leveraged loans; and private equity could be proxied by an index of publicly traded mid-sized companies. When this public equivalent method is used, sometimes an adjustment is made for differentiating factors such as the use of leverage.[3] In practice, the public equivalent method can lead to overstating private asset risk. For example, some public equivalent indices lack the breadth and depth of the equivalent private asset class and thereby exhibit greater volatility than what would likely exist if the private asset class was public.

The remainder of this report instructs on a third, and preferable, *unsmoothing method* to the estimation of private asset risk. It relies upon statistical techniques that unsmooth private asset returns and link those returns to public asset classes.

This first step in unsmoothing private asset returns is understanding how returns become smoothed. The smoothing of periodic (e.g. quarterly) returns is a likely byproduct of asset valuation methods that give (explicit or implicit) recognition to not only information at the valuation date but also information, and thereby valuations, at earlier dates. For example, those charged with valuing illiquid assets as of one date might be influenced by valuations from earlier dates. This "anchoring" to earlier valuations can be behavioral or process driven. A behavioral example might be a sharp change in asset value based on current inputs that is modified to reflect "normalized" inputs that take account of previous input values. A process driven example could be a valuation protocol that occurs only once a year with intermediate values based upon cash flows only or a protocol that conducts a full valuation on only 25% of the assets every quarter.

Unsmoothing Returns

The same Markowitz equations used to calculate portfolio risk based upon standard deviation and correlation across multiple assets can be adapted to unsmooth returns of a single asset. A single asset's unsmoothed risk is found by aggregating the asset's smoothed risk over multiple time periods, knowing its period-to-period serial correlation[4], then reverse engineering the multi-period risk calculation to a new <u>un</u>smoothed single period risk using the same formula but assuming no (zero) serial correlation.

An example is instructive.

Assume a single asset whose return is suspected of being smoothed through an imperfect quarterly valuation process. The observed risk for this asset is given by its standard deviation of quarterly return ($\sigma_{smoothed}$), but the value is perceived to be suspiciously low due to a non-market valuation process that could produce smoothed returns with a measured standard deviation below what it should be. The presence of smoothing can be tested for by calculating the serial correlation of return. This involves measuring the correlation of asset returns over some period with the same returns, but time lagged. In our example, this means measuring the correlation between quarterly asset returns with the same returns but lagged one quarter. A positive correlation would indicate that the observed (reported) asset return is partially explained by the return from the prior quarter.

[3] See "Benchmarks for Private Market Investments," Stephen Nesbitt and Hal Reynolds, <u>The Journal of Portfolio Management</u>, (Summer 1997) for a discussion of altering public stock indices for higher leverage found in private equity funds.
[4] The correlation of asset returns across time periods is referred to as "serial" or "auto" correlation.

Equation 1 gives the formula for deriving an equivalent unsmoothed return standard deviation knowing the observable smoothed return standard deviation and the serial correlation. The variable n is the number of time periods over which standard deviation and correlation is calculated.

$$Equation\ 1:\ \sigma_{usmoothed} = \sigma_{smoothed}\sqrt{1 + 2\left(\frac{n-1}{n}\right)\rho_{serial}}$$

Some numerical examples are provided below but it is instructive to first examine Equation 1 closely. If serial correlation equals zero ($\rho_{serial} = 0$), then the unsmoothed standard deviation equals the observed smoothed standard deviation. Second, if the measurement period is very large ($n \to \infty$) then the term $(\frac{n-1}{n}) \to 1.0$ and the unsmoothed return will equal the smoothed return multiplied by a constant ranging between 1.0, when serial correlation equals 0.0 and $\sqrt{3}$ when serial correlation equals 1.0.

Equation 1 is derived based upon the presence of a single period lag only. The presence of multi-period lags can also be derived with formulations that look like Equation 1 but with different coefficients attached to the smoothed standard deviation.

Private equity and real estate are two examples of asset classes whose returns have historically exhibited serial correlation due to valuation practices. Together with private debt, benchmarked by the Cliffwater Direct Lending Index (CDLI), measurements for standard deviation and serial correlation for the Cambridge Associates (CA) US Buyout Index and the NCREIF Property Index are reported in Exhibit 2 using quarterly data going back to September 30, 2004, which marks the start date for the CDLI, through December 31, 2018. Risk measures for publicly traded asset classes representing stocks, credit, and rates are also included for comparison purposes. The risk calculations all use quarterly data for consistency.

Exhibit 2: Risk Calculations for Illiquid Assets: Sept 2004 to Dec 2018

		Cambridge Associates US Buyout Index	NCREIF Property Index (NPI)	Cliffwater Direct Lending Index (CDLI)	Russell 3000 Index	S&P/LSTA Levered Loan Index	10-year Treasury
1	Quarterly Smoothed Std. Dev.	4.71%	2.66%	1.72%	7.66%	4.97%	1.85%
2	Annualized Smoothed Std. Dev.	9.42%	5.32%	3.43%	15.32%	9.94%	3.70%
3	Serial Correlation (1 quarter lag)	0.42	0.85	0.38	0.17	0.24	-0.02
4	R-Squared	17%	73%	14%	3%	6%	0%
5	T-Statistic (significance test)	3.92	11.74	2.93	1.33	1.74	-0.04
6	Quarterly Unsmoothed Std. Dev.	6.38%	4.38%	2.27%	8.86%	6.03%	1.81%
7	Annualized Unsmoothed Std. Dev.	12.76%	8.76%	4.55%	17.72%	12.06%	3.61%
8	% Increase in Std. Dev.	35%	65%	33%	16%	21%	-2%
9	Correlation to Russell 3000	0.77	0.24	0.67	1.00	0.67	-0.56
10	Unsmoothed Correl to Russell 3000	0.74	0.48	0.58			

Line 1 reports standard deviations based upon directly observed quarterly returns for the entire 14.25-year period. The "smoothed" designation suggests that risk calculations might be downward biased due to valuation imperfections, at least for the private asset classes in the first three columns. These quarterly standard deviations are annualized in line 2.[5] At first glance, the comparatively low standard deviations for the illiquid asset classes might raise suspicion that some type of smoothing of valuation is present in the quarterly data.

Line 3 reports serial correlation in one quarter lagged returns for each data series. Said otherwise, serial correlation equals the correlation between quarterly returns and the same quarterly returns but lagged one quarter. This is a statistical method for identifying to what extent last quarter's return explains the current quarter return. Theoretically there should be no correlation.

Instead, line 3 reports positive serial correlation for all asset classes, but for 10-year Treasuries. The highest serial correlation is 0.85 for the NCREIF Property Index (NPI). The square of the correlation, better known as R-squared in line 4, means that 72% of the NPI return for any quarter can be explained by the prior quarter's return. This value is surprisingly high. Correlation and R-squared values for the Cambridge US Buyout and Cliffwater Direct Lending Indices are a much more modest 0.42 (18%) and 0.38 (14%), respectively.

Line 5 reports the t-statistic for the correlations in line 3. The t-statistic gives the level of statistical confidence in the serial correlations given in line 3. A t-statistic value above 2.50 carries a very high (99%) level of confidence that smoothing is present. A t-statistic much below 2.50 suggests that the serial correlation value may really be zero despite the calculated value or there may not be sufficient data to reach a conclusion. Based on the t-statistic values, real estate exhibits a high and statistically significant stickiness in valuation while the Cambridge Buyout and Cliffwater Direct Lending quarterly returns display a statistically significant but much more modest smoothing. Quarterly returns for the publicly traded equity (Russell 3000) and credit (S&P/LSTA Leveraged Loan) indices also exhibit positive correlation, but together with 10-year Treasuries, the values have low t-statistics and therefore not statistically significant. The small positive serial correlations for stocks and leveraged loans are likely caused by returns during the Financial Crisis when unexpected negative feedback loops in markets generally caused price trending among some liquid asset classes.

Lines 6 and 7 "unsmooth" the smoothed standard deviations in lines 1 and 2, respectively, with line 8 showing the percentage increase in standard deviation resulting from the unsmoothing process. The unsmoothing process increases standard deviation across all asset classes, except 10-year Treasuries, with real estate risk increasing 65%; private equity and private debt increasing by 35% and 33%, respectively; and stocks and leveraged loans increasing 16% and 21%, respectively.

A formulation for developing an unsmoothed quarterly return series is given in Equations 2 and 3.

$$Equation\ 2\!:\ Return^{t}_{smoothed} = \beta * Return^{t}_{unsmoothed} + (1-\beta)Return^{t-1}_{smoothed}$$

Where:

$t = current\ quarter$

$\beta = weight\ given\ to\ unsmoothed\ return$

Equation 2 posits that the reported, and smoothed, return for an illiquid asset ($Return^{t}_{smoothed}$) is a weighted average of its "true" unreported and unsmoothed return ($Return^{t}_{unsmoothed}$), and the reported and smoothed return for the prior period ($Return^{t-1}_{smoothed}$). The weights, or betas, sum to 1.0 and equal the serial correlation, such as reported in line 3 in Exhibit 2.[6]

[5] Annualizing quarterly standard deviations in the normal way (assuming zero serial correlation) requires multiplying by the square root of time, or 2.0 (=$\sqrt{4}$).

[6] Beta equals serial correlation multiplied by the ratio of standard deviation of the dependent and independent return series. Since there is but one series, only lagged, the standard deviations are the same and the ratio equals 1.0, leaving beta equal to the serial correlation.

Equation 2 is not very intuitive because valuation firms produce asset values, not asset returns. Exhibit 3 restates the Equation 2 but in terms of asset value rather than return.

$$Equation\ 3\colon\ V_s^t/V_s^{t-1} = \beta * V_u^t/V_u^{t-1} + (1-\beta)(V_s^{t-1}/V_s^{t-2})$$

Where:

$V_s = smoothed\ or\ reported\ asset\ value$
$V_u = unsmoothed\ or\ true\ asset\ value$

Equation 3 shows that the one period return lag incorporates valuations that are two periods old. The "anchoring" of valuations that creates return smoothing can be modeled in many ways, but the approach described in Equations 2 and 3 provides both a plausible description of valuation behavior with significant statistical support.

Equation 4 rearranges Equation 2 to solve for unsmoothed return.

$$Equation\ 4\colon\ Return_{unsmoothed}^{t} = \frac{Return_{smoothed}^{t} - (1-\beta)Return_{smoothed}^{t-1}}{\beta}$$

As an example, Equation 4 is applied to the CDLI quarterly total return series to create an unsmoothed CDLI return series (see Appendix A). The unsmoothed return series can then be used to adjust correlations between asset classes that might have been understated due to smoothing. Lines 10 and 11 provide smoothed and unsmoothed correlations to the Russell 3000 for the asset classes where serial correlation is statistically significant. As expected, the unsmoothed correlation to the Russell 3000 is most different from the smoothed correlation where serial correlation is the greatest. The correlation between the NPI and Russell 3000 doubles from 0.24 to 0.48.

Risk Measure Consensus

Capital market assumptions for return and risk largely drive investor asset allocation. Understanding the return behavior of illiquid investments, like serial correlation, would seem to be important in making good decisions about their risk. That is the purpose of this report. The annual *Survey of Capital Market Assumptions* from Horizon Actuarial Services LLC is a useful commercial survey to understand and compare the inputs advisors are using to inform investor asset allocation.

In their *2019 Survey*, Horizon reports the average standard deviation for public equity among 34 consultants equals 16.17%, not too different from the 17.72% standard deviation calculated above (Exhibit 2, line 7). Similarly, if Exhibit 2 was expanded to include most other traditional liquid asset classes, risk estimates would be consistent with the *2019 Survey*.

On the other hand, risk forecasts for illiquid asset classes used by consultants averaged well above our unsmoothed risk calculations in Exhibit 2. For example, consultant standard deviation forecasts for private equity average 22.05% according to the *2019 Survey*. That compares to the 12.76% standard deviation for the Cambridge US Buyout Index calculated in Exhibit 2. The absence of Non-US private equity and venture capital probably account for some of this difference but less than one-half.[7] Outsized risk forecasts among consultants exist for real estate and private debt as well. The 15.03% and 11.62% *2019 Survey* forecasts for real estate and private debt, respectively, are well above 8.76% and 4.55% calculations found in Exhibit 2.

[7] Cliffwater calculations.

The higher risk forecasts for real estate and private debt reflected in the *2019 Survey* could be explained by consultant inclusion of more risky illiquid assets, such as strategies that use leverage or focus more on higher cap rate, higher yield assets, or the presumption that illiquid portfolios will be less diversified than the benchmarks suggest. These considerations would undeniably increase risk forecasts beyond Exhibit 2 calculations.

Another source for risk estimates is the Cliffwater database of state pension returns, going back to 2002. Risk numbers for this database use annual returns which do not display serial correlation. These actual risk statistics provide additional perspective. For example, the average state pension experienced a 15.44% standard deviation for its private equity portfolio over the time period 2002 to 2018, which is more in line with the 12.76% value in Exhibit 2 than the 22.05% average consultant forecast. On the other hand, state pension real estate returns experienced a 12.78% risk for the same time period, which is somewhat more consistent with consultant forecasts. Private debt returns for state pensions have much less history and are therefore are less useful.

Conclusion

Risk calculations for illiquid assets are challenging, based upon valuations, and therefore returns, using “fair value” methods at quarterly time periods. While this process can cause a smoothing of returns and understatement of risk, statistical tests are available to correct for the error. Still, illiquid asset portfolios are not nearly as homogeneous as stocks and bonds, making their index benchmarks less representative of actual portfolio risk, and thereby understating risk. That certainly seems true for private real estate. On the other hand, consultant forecasts for private equity risk appear overstated compared to benchmark risk and actual portfolio results. Allocators should take a holistic approach to risk estimation, examining benchmark and actual portfolio returns while questioning authenticity through statistical testing for valuation smoothing.

Stephen L. Nesbitt
CIO
Cliffwater LLC

Appendix A: Unsmoothed CDLI Quarterly Returns

Quarter Ending	Cliffwater Direct Lending Index (CDLI)	"Unsmoothed" CDLI	S&P/LSTA Levered Loan Index
Dec-04	2.35%	3.03%	1.38%
Mar-05	1.90%	1.63%	1.36%
Jun-05	2.37%	2.65%	0.64%
Sep-05	2.68%	2.87%	1.77%
Dec-05	2.78%	2.85%	1.20%
Mar-06	2.89%	2.96%	1.96%
Jun-06	3.50%	3.88%	1.02%
Sep-06	3.52%	3.53%	1.71%
Dec-06	3.14%	2.90%	1.88%
Mar-07	3.74%	4.11%	2.03%
Jun-07	4.12%	4.36%	1.43%
Sep-07	0.95%	-1.00%	-1.23%
Dec-07	1.10%	1.19%	-0.14%
Mar-08	-1.14%	-2.51%	-5.74%
Jun-08	2.50%	4.74%	4.94%
Sep-08	-1.12%	-3.34%	-6.99%
Dec-08	-6.68%	-10.09%	-22.94%
Mar-09	2.33%	7.85%	9.80%
Jun-09	2.82%	3.13%	20.38%
Sep-09	3.94%	4.62%	10.53%
Dec-09	3.49%	3.22%	3.78%
Mar-10	3.38%	3.30%	4.64%
Jun-10	3.83%	4.11%	-1.28%
Sep-10	3.36%	3.06%	3.31%
Dec-10	4.37%	4.99%	3.19%
Mar-11	3.88%	3.58%	2.43%
Jun-11	2.41%	1.50%	0.18%
Sep-11	-0.18%	-1.76%	-3.85%
Dec-11	3.35%	5.52%	2.91%
Mar-12	3.97%	4.35%	3.76%
Jun-12	2.45%	1.53%	0.75%
Sep-12	3.74%	4.53%	3.43%
Dec-12	3.19%	2.85%	1.42%
Mar-13	3.20%	3.21%	2.11%
Jun-13	2.62%	2.26%	0.19%
Sep-13	3.13%	3.44%	1.20%
Dec-13	3.18%	3.21%	1.70%
Mar-14	2.90%	2.73%	1.20%
Jun-14	2.81%	2.76%	1.38%
Sep-14	2.42%	2.18%	-0.47%
Dec-14	1.12%	0.32%	-0.51%
Mar-15	2.45%	3.27%	2.13%
Jun-15	2.46%	2.46%	0.69%
Sep-15	0.82%	-0.18%	-1.35%
Dec-15	-0.28%	-0.95%	-2.10%
Mar-16	1.52%	2.63%	1.55%
Jun-16	3.62%	4.90%	2.92%
Sep-16	3.05%	2.71%	3.08%
Dec-16	2.61%	2.34%	2.26%
Mar-17	2.36%	2.21%	1.15%
Jun-17	2.00%	1.79%	0.76%
Sep-17	1.97%	1.95%	1.04%
Dec-17	2.02%	2.05%	1.11%
Mar-18	2.18%	2.28%	1.45%
Jun-18	2.44%	2.60%	0.70%
Sep-18	2.38%	2.34%	1.84%
Dec-18	0.84%	-0.10%	-3.45%
Mar-19	2.78%	3.97%	4.00%
Annualized Return	9.62%	9.61%	4.70%
Annualized Risk	3.40%	5.10%	9.88%
Max Drawdown	-7.73%	-13.09%	-28.33%

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Any information presented prior to the Launch Date (September 30, 2015) of the CDLI is back-tested. Back-tested performance is not actual performance, but is hypothetical. Unless otherwise indicated, the back-tested calculations are based on the same methodology that was in effect when the CDLI was officially launched. Please refer to the methodology paper for the CDLI (available at www.CliffwaterDirectLendingIndex.com) for more details about the CDLI, including the Base Date/Value (September 30, 2004 at 1,000) and the Launch Date of the CDLI and the manner in which the CDLI is reconstituted and the eligibility criteria for the CDLI. Prospective application of the methodology used to construct the CDLI may not result in performance commensurate with any back-tested returns shown. The back-test period does not necessarily correspond to the entire available history of the CDLI. Another limitation of back-tested hypothetical information is that generally the back-tested calculation is prepared with the benefit of hindsight. Back-tested data reflect the application of the CDLI methodology and selection of CDLI constituents in hindsight. No hypothetical record can completely account for the impact of financial risk in actual trading. For example, there are numerous factors related to the financial markets in general which cannot be, and have not been accounted for, in the preparation of the CDLI information set forth, all of which can affect actual performance. When Cliffwater was unable to determine the nature of a BDC's investments because of limited information included in historical SEC filings, Cliffwater did not apply the portfolio composition criteria (a substantial majority (approximately 75%) of reported total assets are represented by direct loans made to corporate borrowers, as categorized by each BDC and subject to Cliffwater's discretion) to the BDC. In addition, the criteria regarding the timing of SEC filings was not applied for periods prior to the Launch Date of the CDLI. All other eligibility criteria were applied to determine whether to include the BDC in the historical CDLI composition and return. CDLI returns generally are published 75 days after calendar quarter-end.

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The Cambridge U.S. Buyout Index is based on data compiled from U.S. institutional-quality buyout funds, including fully liquidated partnerships, formed between 1986 and 2016.

The NCREIF Property Index is a quarterly time series composite total rate of return measure of investment performance of a very large pool of individual commercial real estate properties acquired in the private market for investment purposes only. All properties in the index have been acquired, at least in part, on behalf of tax-exempt institutional investors.

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