Yin and Yang: how private assets and derivatives can work together

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Data suggests that not only do many private assets provide stronger returns than public market equivalents, but also that their risk characteristics are no worse, or even better. As such, for many institutions, significant use of private assets makes sense.

So why are private assets not more widely used?

Concern over portfolio liquidity tends to explain why private asset allocations are generally well below the theoretical optimum. However, if overall liquidity is a concern, it is usually the risk of significant downside volatility in the *liquid* public market component of a portfolio that limits how much the investor can afford to allocate to private assets.

In this context we make two key observations:

- **Taming market volatility in liquid public assets - using equity risk management techniques - can create more capacity for holding illiquid private assets. This can improve overall portfolio efficiency on a variety of metrics.**
- **If we look at the same solution from another angle, instruments such out-of-the-money put options are an efficient liquidity management tool for private assets. Paired with these assets, they can deliver additional liquidity when it is most needed.**

So, we can view equity risk management solutions as *either* improving downside risk characteristics of liquid assets *or* improving the liquidity characteristics of private assets.

Looking at it either way, we find that:

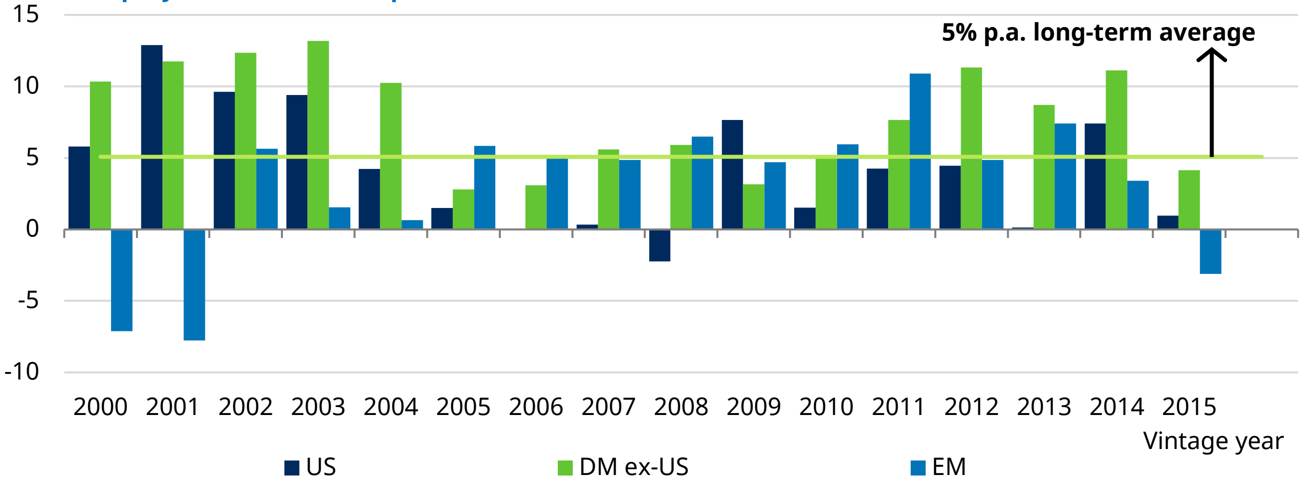
- **Insuring against shortfalls in liquid public assets enables higher allocations to private assets**
- **The expected additional returns achieved by this increased allocation to private assets appears to more than cover the cost of the insurance and improves return per unit of downside risk.**

Importantly, we also conclude that although we focus our example on private equities as the quintessential private asset, our conclusions apply more widely to private assets. In particular, we note that derivative instruments do not necessarily need to be specific to the private asset concerned. Instead, the key benefits of the technique discussed are captured by derivatives based on broad public market exposures.

The return and risk characteristics of private assets

Many studies indicate that private assets offer a significant risk premium above public market comparators, even allowing for higher asset management costs. A comparison of private equity returns across vintages 2000 to 2015 reveals the average premium (net of fees) to be around 5% per annum (p.a)[1].

Private Equity excess returns % p.a.



Sources: Cambridge Associates benchmarks, Schroders

One possible explanation for these abnormal excess returns is that the true volatility of private assets is understated due to "serial correlation" of returns (i.e. one quarter of negative returns tends to be followed by another). However, we find that even after removing serial correlation in private equity returns using, for example, the methodology of Fisher, Geltner & Webb , the adjusted volatility appears no worse that that of developed market equities.

	Recorded volatility	Adjusted volatility (serial correlation removed)
Private Equity	**9.2%**	**13.9%**
MSCI World Developed	16.2%	16.2%

Source: Schroders, MSCI

Furthermore, although private equity returns show evidence of being "fat tailed" relative to a standard normal distribution, this fat-tail does not appear to be markedly worse than that displayed by public market equities[2].

Implications for asset allocation

The implication of the above characteristics is that unconstrained portfolio optimisation would result in very high allocations to private assets. This can be illustrated by starting with a theoretical portfolio allocated 100% to equities benchmarked against the MSCI World index. We can then calculate how much of the portfolio would be replaced with private equities to maximise the Sharpe Ratio of the resulting portfolio for various assumed expected excess returns[3]. We can calculate this for both the recorded volatility and adjusted volatility set out in the previous table. We allow this "replacement" to exceed 100% in theory for illustration purposes only.

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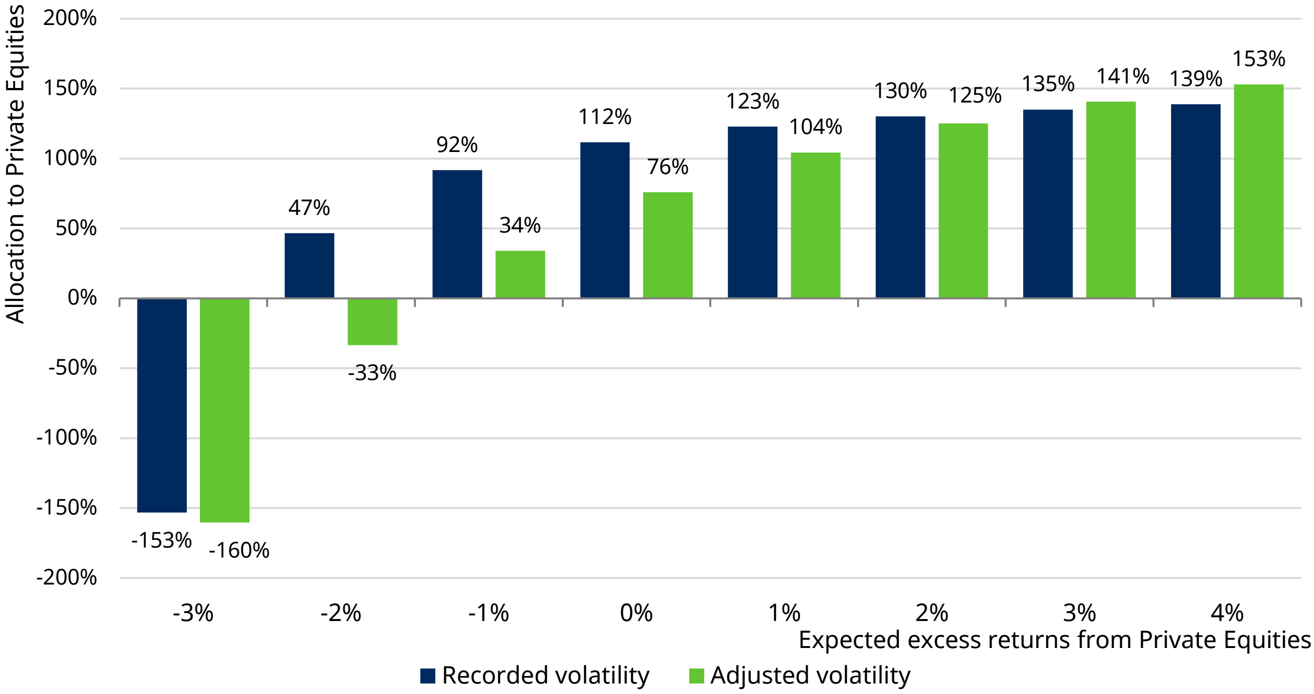
[1] Sources: Cambridge Associates benchmarks, Schroders. Vintage year returns refer to returns from the funds' inception date through to 31 March 2018. Outperformance is calculated based on separate equity benchmarks as follows: Russell 2000 for US, MSCI Europe for DM ex-US, and MSCI EM for EM.
[2] See item A of the Technical Appendix for explanation of the Q-Q plots.
[3] See item B of the Technical Appendix for further explanation of our derivation of the maximum Sharpe Ratio.

The results are shown below:



Source: Schroders

Based on adjusted volatility, even if the risk premium of private equities was only 1% p.a. higher than that of the developed market, the portfolio with maximum Sharpe Ratio would hold no developed market equities!

Back to reality – illiquidity as an allocation hurdle

In the real world, we do not of course see allocations to private assets anywhere near these theoretical levels. One of the main reasons for this is the illiquidity of private assets. Indeed, the risk premium on private assets is often explained as an "illiquidity premium", available only to those who can tolerate illiquidity.

Illiquidity is often a difficult concept to pin down. For many institutions, the immediate requirement for cash flow is well below the available liquidity. We can, however, make sense of liquidity concerns in a number of ways:

- **Provision for multi-year outgoings:** Provision needs to be made for the investors' expected outgoings (e.g. pension payments) over multiple years before the private asset generates any cashflows. Indeed, in the early years the private asset portfolio may itself be drawing down cash for investment, which needs to be provided for.
- **Funding of collateral requirements:** Liquidity may also be required as collateral for derivative positions, particularly for pension funds with interest rate and inflation hedging programmes. Although cash and gilts may be held for immediate collateral requirements, over a number of years other growth assets may need to be sold to top up the collateral pool.
- **Rebalancing:** Liquidity may be required for rebalancing of the portfolio. This to some extent an asymmetric concern. If public assets perform strongly, private asset allocations can in theory be topped up, but if the listed assets suffer heavy losses a secondary market sale of private exposures at the same point in time will realize losses beyond those recognized, through-reported NAV[4]. This makes it impractical to consider private assets as a potential source for liquidity for rebalancing.

It is sometimes argued that illiquidity also creates an "opportunity cost" which prevents investors from taking advantage of other investment opportunities. This of course assumes that these opportunities can be identified ex-ante but broadly speaking it is a similar concern to the rebalancing issue above.

[4] Average discounts to NAV taken on sale of private equity stakes in 2008-2009 exceeded 30%. Source: Greenhill Cogent.

Taming public market volatility – the key to increasing private asset capacity

The important point to note here is that liquidity constraints are usually met simply by ensuring that we have sufficient liquid assets in stressed downside scenarios to fund the liquidity requirement. In other words, we are not usually stressing the liquidity requirement itself – or the illiquid asset - but instead stressing *the residual liquid assets*. However, a stressed event in liquid assets is really just a significant fall in their market value. Thus, the capacity to hold illiquid assets can potentially be increased by managing the downside risk of the *liquid* assets and one of the most effective ways of doing this is through the use of derivative instruments. Furthermore, these derivative instruments need to protect the public market assets being used to fund the liquidity and *not the private assets themselves*. These public market derivative instruments have not, so far, been regarded as a natural partner for private asset strategies. We discuss in the rest of this paper why they should be.

Potential benefit of using derivatives

In the Technical Appendix we construct a simple example which contrasts three potential approaches to allocating to private assets subject to a liquidity constraint:

a. Allocate the maximum amount to private assets that can be achieved without breaching the liquidity constraint in the 99th percentile modelled outcome for liquidity

b. Allocate an additional 10% to private assets (assumed to earn a 3% p.a. higher expected return compared with the public assets), basically ignoring the liquidity constraint to improve return.

c. Allocate an additional 10% to private assets using equity put options to protect the liquid assets (assumed to be invested against an MSCI World Index benchmark) so that the liquidity constraint is not breached

Not unsurprisingly, strategy (B) increases the mean portfolio IRR[5] by around 0.3% p.a. (since we allocate 10% to an asset with a 3% pa higher expected return) but inevitably breaches our liquidity constraint at the 99th percentile level. However, our alternative strategy (C) - with 10% higher private equity allocation combined with put protection - meets the liquidity constraint and still captures two thirds of this improvement in portfolio IRR, after basically spending the remaining one third of the IRR improvement on the put option protection.

Return impact is not the whole story

Although there is a clear case for using protection techniques based on improved excess return alone, it is worth remembering as ever that as the equity downside protection reduces risk it also has value in its own right: the net cost of paying option premiums is not simply "lost". While the use of protection can facilitate higher investment in illiquid assets to improve overall expected return, it also reduces the downside risk of the overall portfolio. Firstly, it should be noted that the hard put option protection means that the liquidity constraint is satisfied in *any* scenario, not just in scenarios better than the 99th percentile. Secondly, and perhaps more importantly, in the model described above we find that including the put option protection reduces Value at Risk (VaR) at both the 95th and 99th percentile levels, relative to the base strategy (A). It also achieves a similar improvement in "Return per £ VaR" to that of strategy (B) with the higher private asset allocation and no put protection.

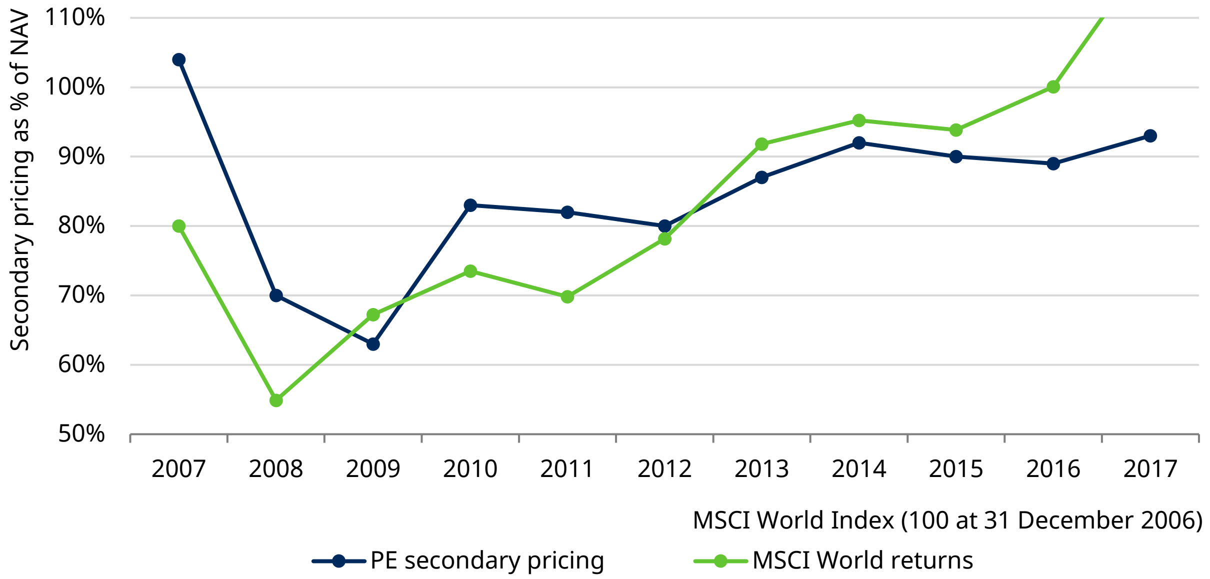
Indeed, the solution could equally be thought of as subsidising the cost of risk management using the illiquidity premium. An investor concerned about developed market equity valuations could potentially implement the above put strategy to address downside risk and use an allocation to illiquid assets to mitigate the cost impact on expected return.

Looking at it another way: Notionally pairing the risk management with the private asset

Although we have effectively assumed zero liquidity for the private asset allocation, there is almost surely a price at which you could sell it, just possibly not the price at which you would like to do so. In other words, to some extent "illiquidity" of private assets is in the eye of the beholder. As seen below, in periods of public

[5] IRR in excess of the risk free rate implied by the mean outcome. In looking at the monetary amounts compared with these percentages it should be borne in mind that that the assets are being depleted over time due to the payment outflow.

market stress (i.e., 2008), liquidity in the secondary private assets decreases significantly, as represented by average transaction pricing of private equity as a percentage of NAV[6].



Source: Greenhill Cogent, Bloomberg, Schroders

Thus, instead of thinking of the equity protection strategy being paired with the 50% allocation to developed market equities above, we can equally think of the protection being paired with the 50% allocated to private equity investment – the notional pairing is purely a matter of choice. Pairing the protection with the private equity in this way can then be viewed as improving its liquidity by providing a targeted "liquidity shot" during periods of public market distress rather than managing downside risk of the private asset per se.

Importantly, this technique can potentially be also applied to a wide range of private assets, not just private equity, given that the discount to NAV observed in private assets generally would be expected to increase during periods of extreme market distress in public markets. So once again, the derivative instrument does not necessarily need to be specific to the private asset itself to provide valuable liquidity support.

Conclusions

We have focussed in this paper on the purchase of out of the money equity puts and based our example on a private and public equity portfolio. However, a whole toolbox of risk management techniques could of course be considered, including volatility control, volatility caps and other flavours of option protection while the basic principles of liquidity management using these techniques apply to many other private assets.

Our key observation is that this risk management can be viewed in two ways:

- When notionally paired with listed equities it limits downside risk in the value of the liquid asset being used to fund liquidity requirements or
- When notionally paired with the private equity assets it adds a "liquidity shot" to the illiquid asset precisely when overall portfolio liquidity is most needed

Viewed either way, these techniques can increase capacity to invest in private assets, which in turn improves overall portfolio efficiency.

Importantly, we find that by increasing the capacity to hold illiquid assets, the cost of the risk management is more than covered by the higher expected return of the resulting strategy. As a bonus, the strategies also of

[6] Source: Greenhill Cogent, Bloomberg, Schroders. As of March 2018.

course benefit from potentially very valuable downside risk management on the overall portfolio. Furthermore, we argue that as the derivative exposures need to either hedge the market values of public market assets used to finance liquidity or, equivalently, add liquidity to private assets during periods of high NAV discounts, it follows that the derivatives themselves do not necessarily need to be specific to the private asset itself.

In conclusion, there has been significant interest recently in the idea of combining various forms of private assets to provide blended solutions. We would suggest that derivative based risk management strategies should be considered alongside illiquid assets as part of these blended solutions, potentially creating overall strategies with higher return, lower risk and enhanced liquidity.

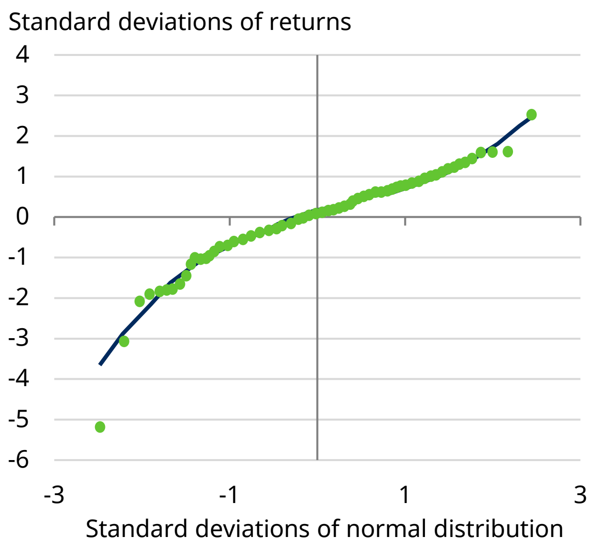
Technical Appendix

a. **"Fat tailed-ness" of private and public equity markets:** This can be illustrated using so-called "Q-Q" plots of quarterly returns on private and public equity market returns. This technique maps quarterly log returns onto the standard normal distribution in such a way that a straight line plot indicates normality while steeper curvature on the left hand side indicates "fat tails".

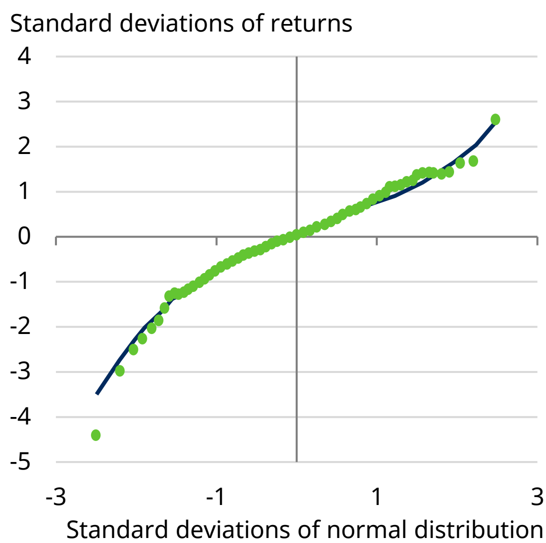
   For the Q-Q plots shown below we standardise the quarterly log returns by subtracting the mean and dividing by the standard deviation and ranking these from smallest to largest. We then compare these with the rankings that would be expected (in terms of standard deviations from the mean) from a standard normal distribution and fit using "least squares" a cubic polynomial of the form $W_n = f(Z) = aZ_n^3+bZ_n^2+cZ_n+d$ where W_n is the n^{th} ranked standardised return on the asset and Z_n is the n^{th} ranked standard Normal variation subject to the constraint that $E[W] = 0$ and $E[W^2] = 1$.

   The results are shown below for private and public market equities together with a cubic best fit (in red). As is evident visually, the two best fit lines are almost identical, suggesting similar downside tail characteristics.

Private Equity



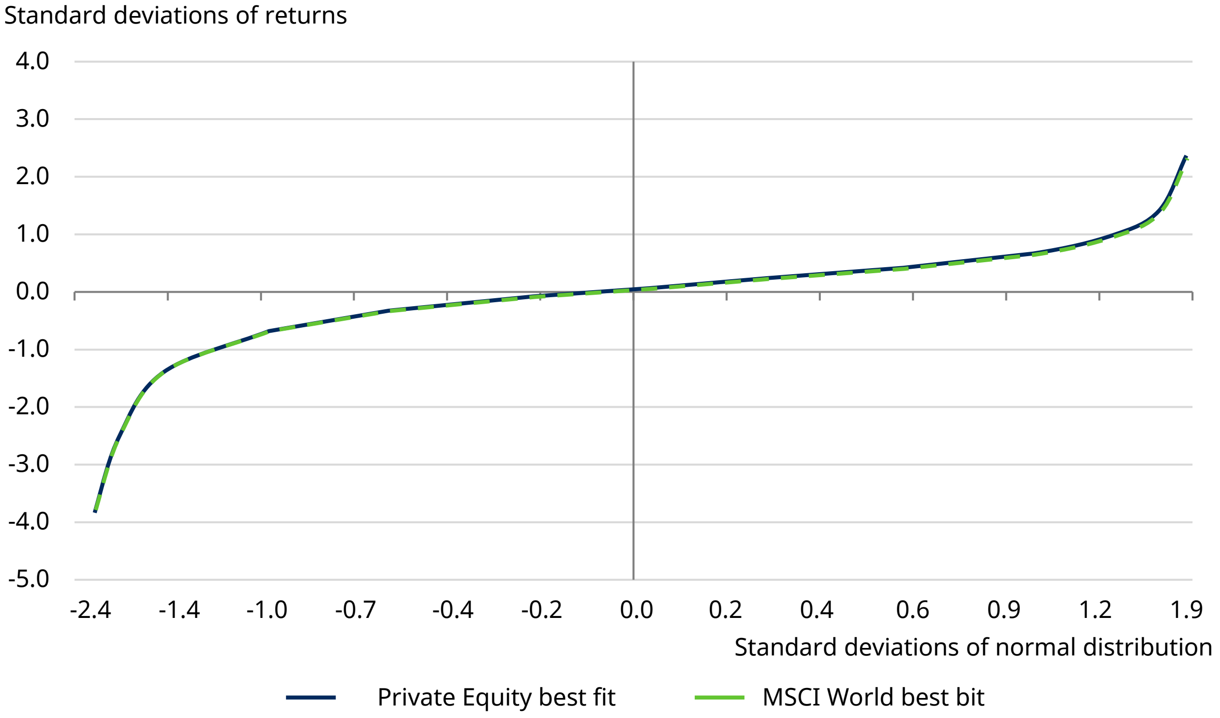
MSCI World



The fitted parameters are as follows. Comparison of the fitted polynomials for private equity and MSCI World equity returns is shown below.

Cubic best fit	a	b	c	d
MSCI	0.1047162	-0.1069992	0.6404767	0.1072639
PE	0.1218485	-0.1220164	0.5731458	0.1224962

A comparison of the fitted polynomials for private equity and MSCI World equity returns is shown below.



b. **Maximum Sharpe Ratio:** The maximum Sharpe ratio portfolio is derived from the standard CAPM result that the portfolio is parallel to the vector $\mathbf{x^*} = \mathbf{\Omega^{-1}e}$ where $\mathbf{\Omega}$ is the 2x2 covariance matrix between MSCI World equity returns and private equity returns and $\mathbf{e}$ is the expected excess return vector. The optimal portfolio $\mathbf{x} = k\,\mathbf{x^*}$ with k chosen to make the elements of $\mathbf{x}$ sum to 100%. The "replacement" percentage quoted is the allocation to private equity in $\mathbf{x}$.

c. **Asset model**:

i. **Asset expected return assumptions:** We assume that "risk free" interest rates are 1% p.a. (r in formula in (2) below) and the developed market and private equity risk premia (μ in formula in (2) below) 3% p.a. and 6% p.a. respectively.

ii. **Asset risk assumptions:** We assume that developed market equities have a volatility (σ in formula below) of 16% p.a. and private equities a volatility (σ) of 14% p.a., both with the empirical "fat tailed" return distributions described below based on the following process:

$$\textit{Equity total return index value} \sim \exp[\, r + \mu - \sigma^2/2 + \sigma f(Z)\,]$$

Where Z is normally distributed and $f(Z) = aZ^3 + bZ^2 + cZ + d$. We follow a two stage process to fit the model to annual returns. Firstly, parameters a, b, c and d are fitted to quarterly return data[1] as described in (1) above.

Returns generated from these parameters are then compounded quarterly to produce annual returns which are then re-fit to the same distribution form with the same constraints. This gives the following annual return parameters:

Cubic best fit	a	b	c	d
MSCI	0.0375469	-0.0746084	0.8775151	0.0746084
PE	0.0465053	-0.0869250	0.8463406	0.0869250

iii. **Asset correlation assumptions:** We assume a correlation of 70% between developed market and private equity.

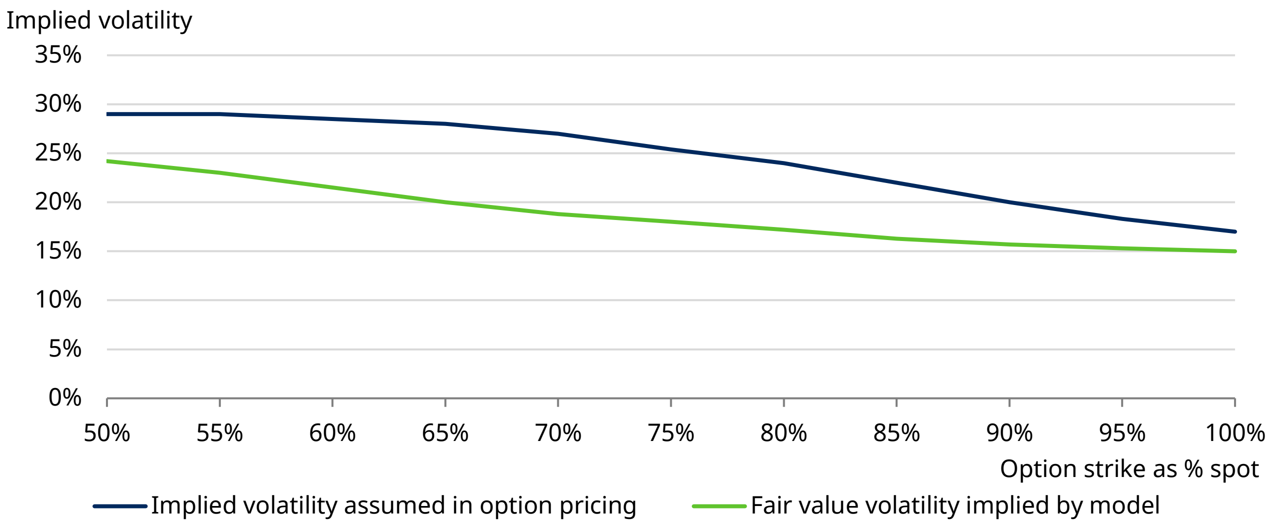
d. **Option pricing model**:

i. **"Fair value" ATM option pricing model:** Developed market equity total return index put option pricing is centred on assumed "fair value" ATM volatility consistent with the asset model described above. This model generates simulated ATM option prices that are equivalent to using 15% p.a. volatility in the standard Black Scholes Model when the overall developed market equity volatility (σ_{MSCI}) is assumed to be 16% p.a.

ii. **Traded ATM option pricing model:** We add a 2.0% p.a. volatility risk premium to the above fair value ATM volatility. In other words, a buyer of ATM options in our model sees market pricing of implied volatility at 17% p.a., which is 2.0%p.a. above the "fair value" level.

iii. **Assumed volatility skew:** The assumed skew is based on the 1-year maturity volatility curve for the MSCI World index as at 31 July 2018 relative to ATM volatility.

iv. **Model derived option pricing:** Overall, the model implies the following relationship between the cost of the options to the buyer in our model and their "fair value" according to the asset model described above. As will be seen, the investor is always assumed to pay a premium above the fair value implied by the model.



v. **Simulated option strategy results:** We apply a minimum option strike of 50% in all scenarios. If an option expires in the money along any simulation path we assume that the subsequent investment strategy invests in the risk free asset for the remaining term. Based on 10,000 simulations (including antithetic simulations), the model implies the following average option strikes and average premium outgo (for initial £100 total fund and initial £60 allocation to developed market equities):

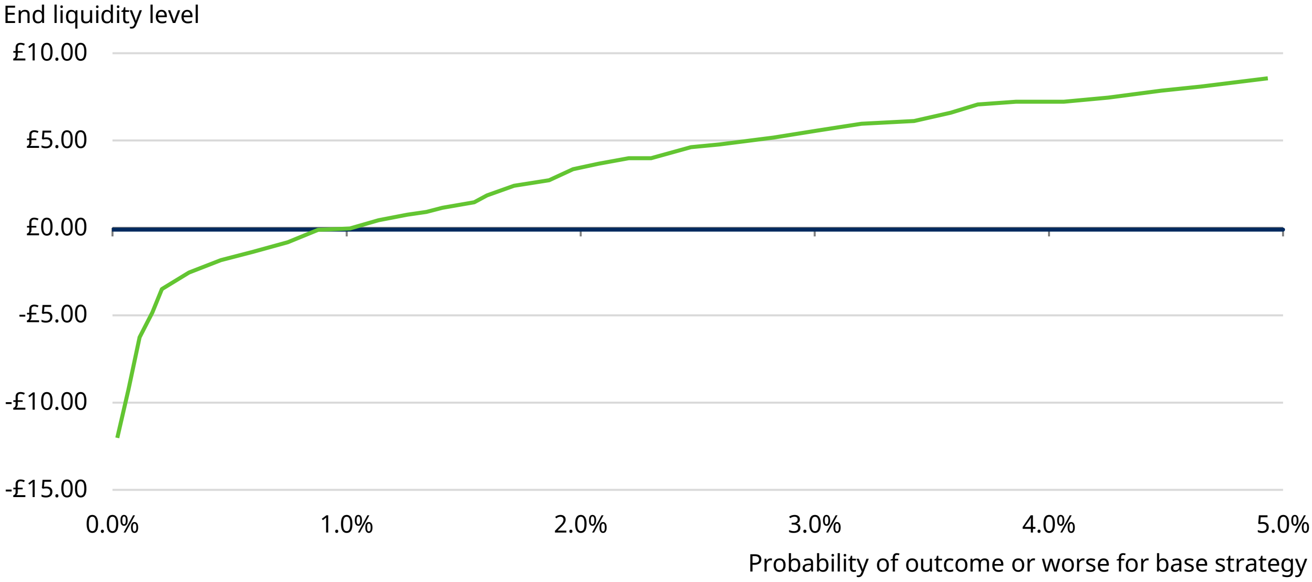
Projection year	1	2	3	4	5
Average strike	68.0%	64.3%	61.5%	59.7%	58.4%
Average premium cost paid	£0.37	£0.39	£0.43	£0.40	£0.25

e. **Model of traditional private asset allocation approach and comparison of alternatives**

Traditional approach

As an example, we use the above model to explore a scenario in which we take £100 of assets that we want to allocate between developed market equities and a portfolio of private equity assets. The private assets portion of the portfolio generates cash outflows only after five years. For the first five years, therefore, we are reliant entirely on the developed market equities for liquidity. Let us also assume that these cash outflows are £6.85 per year, for illustration only.

Our model suggests that we can only afford to allocate 40% of the portfolio to private equities and must retain 60% of the portfolio in the MSCI World total return index at 99% confidence on liquidity. We view this as our "base" strategy. This view maximises the allocation to private equities within the liquidity constraint, noting that confidence of at least 99% in the case of liquidity is not unreasonable, given that failure here would mean that the investor did not have access to any cash to meet commitments.



Alternative approach

We now use the model to simulate a 10% higher allocation to private equity (assumed to earn a risk premium 3% p.a. higher than developed market equities) combined with a strategy of purchasing annual puts. This provides protection to the listed equities struck at a level that ensures that we never fall below a moving floor. This floor is set at the cost of buying risk free assets, to secure the remaining annual cash outflows. The floor therefore covers five years of cashflows initially, then four years, three years etc. Clearly, we could also model higher put strikes to maintain a margin above this floor level, but we choose this strike to illustrate the concept as it represents the absolute minimum level to ensure that the cashflow obligations can always be met. A comparison of the modelled characteristics of base strategy (A) and this alternative strategy (C) is shown in the table below, together with the results for the intermediate strategy (B) with 10% higher private equity allocation without any put option protection:

		(A) Base strategy	(B) 10% increase in private equity	(C) 10% increase in private equity plus puts	Improvement from (A) to (C)
Liquidity position	**99th percentile liquidity**	-£0.12	-£4.98	£0.00	**£0.12**
	99.5th percentile liquidity	-£1.69	-£6.13	£0.00	**£1.69**
	Worst[1] end liquidity	-£11.81	-£14.61	£0.00	**£11.81**
Total assets	**Mean outcome**	£92.33	£94.29	£93.43	**£1.10**
	Median outcome	£88.65	£90.88	£89.87	**£1.22**
	95% VaR[2]	£26.56	£25.08	£25.36	**£1.20**
	99% VaR[2]	£39.68	£38.54	£37.98	**£1.70**
	Mean outcome IRR	4.5%	4.8%	4.7%	**0.2%**
	Return[3] per £ of 99% VaR	£0.56	£0.63	£0.61	**£0.05**

Notes: Numbers may not sum exactly due to rounding. [1]10,000 simulations. [2]VaR is calculated as the downside departure relative to a strategy of 100% investment in risk free assets which has a projected end value of £70.16. [3]Return for the purposes of this ratio is calculated as the Mean excess over the risk free projected end value of £70.16.

It can be seen that for the intermediate strategy (B) without the put option protection, a 10% increase in the private equity allocation, not unsurprisingly, increases the mean IRR[7]by around 0.3% p.a. (since we allocate 10% to an asset with a 3% pa higher expected return). However, although overall it shows the highest "Return per £ VaR", the strategy breaches the liquidity constraint at the 99th percentile level.

On the other hand the alternative strategy (C), with 10% higher private equity allocation combined with put protection, improves mean IRR by around 0.20% p.a.. Basically, this is explained by the assumed 3% p.a. higher expected return on the 10% allocation to private equity (improving expected return by 0.3% p.a.) less the average net cost (premium less pay-out) of the put options on the MSCI world (amounting to around 0.15% p.a.) plus miscellaneous "second order" effects (amounting to around 0.05% p.a.). In addition, strategy (C) reduces VaR at both the 95th and 99th percentile levels relative to the base strategy and achieves a similar improvement in "Return per £ VaR" to that of strategy (B). However, importantly, the put options in strategy (C) ensure that, unlike strategy (B), this strategy never breaches the liquidity constraint.

[7] IRR in excess of the risk free rate implied by the mean outcome.

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