UNIVERSITY OF CAMBRIDGE
Investment Management

**University of Cambridge Investment Management – Discussion Paper**

# CUEF Portfolio: Asset Allocation

**20th April 2023 (revised 11th July 2023)**

## FOR PROFESSIONAL CLIENTS

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## Executive Summary

In September 2019, UCIM set out a strategy advocating a significant reduction in public equity assets in favour of higher-returning but less liquid private equity assets and uncorrelated absolute return and credit assets. The asset allocation targets subsequently approved by the UCIM Board and reviewed by the Investment Advisory Board are included in Appendix 1. UCIM has since conducted a bi-annual exercise evaluating the appropriateness of this asset allocation strategy based on its current long-term forecasts for returns, correlations, and volatility for the CUEF's significant asset classes.

This paper documents UCIM's work for 2023 and comprises four sections. The first sets out UCIM's "Base Case" assumptions, including forecast real returns and volatility for each sub-asset class over a 20-year time horizon. In contrast with the previous asset allocation exercise undertaken in 2021, UCIM's 2023 real return assumption included conservative estimates for manager alpha over benchmark returns to reflect the team's conviction that the CUEF's managers will, on average, outperform market returns over the long term. The Base Case also assumes that the "threshold" asset allocation constraints, agreed by the UCIM Board in June 2022 and reviewed by the Investment Advisory Board, are observed in the optimisation modelling.

The second section of the paper documents three sets of results generated by the mean-variance asset optimisation analysis, based on the Base Case assumptions.[1] The first result is based on the CUEF's asset class split as of 30th September 2022 (the "Current Allocation"). The second uses the CUEF's long-term asset allocation targets agreed by UCIM in 2020 (the "Target Allocation"). The third solves for a point on the efficient frontier to maximise return for a similar level of risk to the Current and Target Allocations (the "Efficient Frontier Allocation"). The third section assesses the robustness of the three aforementioned allocations under three scenarios, in which the anticipated alpha is not achieved, correlations between asset classes are higher, and constraints are narrower. The final section sets out UCIM's recommendation to adjust the allocation targets agreed upon by the UCIM Board in June 2020 to move closer to the efficient frontier.

The model suggests that using the Base Case assumptions, the CUEF's expected real return under both the Current and Target Allocations is around 5.6-5.8% with 14-15% standard deviation. However, the Efficient Frontier Allocation suggests it is possible to generate an annualised 6.8% real return for a similar level of volatility by investing more of the CUEF in private equity, real assets, and absolute return and credit, at the expense of public equity.

To move towards this allocation, UCIM recommends a 5-10%-point reduction in the public equity target from 40% of NAV to a more flexible 30-35% range target. The decline in public equities would be replaced by a 5%-point increase in the target for private equity, and 0-2.5%-points in each of absolute return and credit and real assets targets. This asset allocation should enable UCIM to take advantage of illiquidity premia and greater dispersion in alternative asset classes, whilst maintaining liquidity within the guideline risk limits. The UCIM Board approved these recommendations in April 2023, which were then also reviewed by the Investment Advisory Board.

[1] The asset optimisation exercise is carried out using Monte-Carlo mean-variance modelling in Morningstar Direct Asset Allocation Software (considered the industry standard approach for this purpose).

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## Key Assumptions – Base Case

The following section outlines the key assumptions made in assessing our Base Case. While the assumptions have been agreed upon within the team, UCIM acknowledges the inherent difficulty in making such estimates, as well as the risk of balancing detail with "false accuracy" in light of the long-time horizon used in the exercise. A 20-year forecast was deemed optimal, given the trade-off between the CUEF's long-term horizon and the challenges of forecasting further into the future. Although a ten-year horizon was also examined, the outputs were not materially different at an asset class level given the similarity in inputs; variations between the ten- and twenty-year horizon outputs related more to tactical allocation between sub-asset classes. Key inputs are real returns and standard deviations by sub-asset class, correlations between asset classes, and modelling risk limit constraints on the levels allowed for each asset class and illiquidity, as agreed by the UCIM Board, reviewed by the Investment Advisory Board, and detailed in Appendix 1.

The key Base Case assumptions are shown in Figure 1 below. For each major asset class in which the CUEF is invested, UCIM has made assumptions relating to one or two sub-asset classes. The returns, alpha, and standard deviation assumptions are based on an extensive review of historical averages, historic relative performance of the CUEF's fund managers and available forecasts, debated intensively among the UCIM team. As an overarching comment, the UCIM team's approach has been to take a conservative approach to the Base Case assumptions.

UCIM's rationale for the assumptions set out in Figure 1 appears below, while an explanation of our choice of sub-asset classes can be found in Appendix 2. Given the long-term horizon, we have assumed for simplicity that exchange rate changes will negate inflation differentials, and thus the 3.0% UK inflation rate currently priced based on the 20-year swap curve is assumed across all nominal forecasts of different geographies.

*Figure 1: 20-Year forecast annualised real returns, assumed alpha, and standard deviations*

| Asset Class | Base Case Real Returns (inc. Alpha) | Alpha Assumed | Base Case Real Returns (ex. Alpha) | Standard Deviation |
|---|---|---|---|---|
| **Public Equity** | | | | |
| **Public Equity – Developed Markets** | | | | |
| Public Equity – US | 4.00% | 0.50% | 3.50% | 19.00% |
| Public Equity – DM ex-US | 4.00% | 1.00% | 3.00% | 19.50% |
| **Public Equity – Emerging Markets** | | | | |
| Public Equity – China | 6.50% | 1.50% | 5.00% | 22.50% |
| Public Equity – EM ex-China | 7.50% | 1.50% | 6.00% | 21.00% |
| **Private Equity** | | | | |
| Private Equity – Buyout | 8.50% | 1.50% | 7.00% | 21.00% |
| Private Equity – VC and Growth | 10.50% | 3.50% | 7.00% | 30.00% |
| **Absolute Return and Credit** | | | | |
| Absolute Return | 3.75% | 2.75% | 1.00% | 6.00% |
| High Yield Corporate Bonds | 3.00% | 0.00% | 3.00% | 9.50% |
| Investment Grade Corporate Bonds | 1.50% | 0.00% | 1.50% | 6.00% |
| **Real Assets** | | | | |
| Real Estate | 4.00% | 1.50% | 2.50% | 11.00% |
| Natural Resources | 3.50% | 1.00% | 2.50% | 15.00% |
| **Cash and Fixed Income** | | | | |
| Cash | -0.25% | 0.00% | -0.25% | 5.50% |
| UK Inflation-Linked Government Bonds | 0.25% | 0.00% | 0.25% | 1.50% |
| UK Government Bonds | 0.25% | 0.00% | 0.25% | 5.00% |

Public Equity – US: UCIM's real return assumption of 3.5% is largely based on market forecasts and is consistent with the historic rolling nominal average, adjusted for inflation. While the US stock market is highly efficient, UCIM's managers generally exploit less efficient parts of the market, giving UCIM confidence to assume a 0.5% alpha.[1] The forecast volatility of 19.5% is based on the 20-year historic average of price volatility in US indices, weighted disproportionately more towards the Russell 2000 index of small-cap stocks to reflect the CUEF's greater exposure to less efficient but more volatile parts of the market such as small caps and biotechnology.

Public Equity - Developed Markets excluding US ("DM ex-US"): To arrive at the DM ex-US real return assumption of 3.0%, UCIM reviewed a wide array of 20-year forward forecasts and overlaid that data with historic performance. Over the last 50 years, DM ex-US has underperformed the US by 1-2%. However, UCIM has assumed future underperformance of "just" 0.5%, given the continued extreme valuation dispersion between the regions. That said, the 1.0% alpha assumption for DM ex-US is higher than that assumed for the US, given greater market inefficiencies and the specialised nature of the CUEF's managers. The 19.5% assumed volatility relies on relevant indices' 20-year average of historic price volatility.

Public Equity – China: Forecasting real returns for Chinese public equities requires significant judgement given the structural changes making historic returns less relevant. UCIM deemed a 5.0% real return assumption to be reasonable, given the depressed equity valuations today and numerous forecasts that economic growth in the region is likely to continue to outperform developed

[1] These figures have been compared to the CUEF's historic manager outperformance.

markets over the next 20 years. The forecast is, moreover, below wider market expectations for 20-year real returns in the range of 6-7% per annum, most of which were released before the disruptive events in the second half of 2022. UCIM's alpha forecast for the region of 1.5% is justified by the often politically-driven dispersion and high inefficiency in the market, which we believe local expert managers can identify and exploit. This dispersion has been demonstrated by CUEF's managers' historical outperformance of indices. The 22.5% volatility is based on the historical 20-year average volatility of the CSI 300 and Hang Seng indices.

Public Equity – Emerging Markets excluding China ("EM ex-China"): UCIM's 6.0% per annum real return assumption for emerging markets other than China considers a wide range of market participants' forecasts. The 1.0% outperformance of EM ex-China relative to China was deemed reasonable, given that the rapid development of China during the past few decades may mean there is more limited potential for outperformance over the next 20 years. The 1.5% alpha is supported both by the inefficiency of these markets, although the relative nascence of manager talent could act as a headwind. The 21.0% volatility is based on the 20-year average of historical price volatility across a blend of emerging market indices.[2]

Private Equity – Buyout: UCIM applied a 7.0% real return assumption after reviewing both the 40-year historic average return of 15.0% nominal per annum for buyout and a wide range of market assumptions for private equity returns which suggested returns of around 10.5% nominal per annum returns for the median private equity manager. The return assumption is deemed reasonable as it adopts a 20-year horizon, within which private market outperformance may decrease over time due to greater competition. The alpha assumption of 1.5% results from the private market performance dispersion and UCIM's judgement of its manager selection. The 21.0% volatility is based on the average of available forecasts, which range from 20% to 22% and aligns with historical averages.

Private Equity – Venture Capital and Growth Equity ("VC and Growth"): The real return assumption of 7.0% reflects the 40-year historic average return of around 16.0% nominal per annum for venture capital and growth equity and UCIM's review of a wide range of market forecast returns for private equity (which averaged 10.5% nominal per annum). The alpha assumption of 3.5% reflects Cambridge Associates and Pitchbook data on the dispersion of venture capital managers' returns (see Appendix 2) and the UCIM team's judgement that it will continue to be able to select venture capital and growth equity managers capable of outperforming the median. The volatility of 30.0% is in line with an even split of the 40-year standard deviations of Cambridge Associates' venture capital and growth equity benchmarks.

Absolute Return: UCIM has categorised directional long-short equity as public equity within CUEF. Accordingly, the absolute return portfolio deliberately invests in assets that display a low correlation to equity. Given these less-correlated assets typically generate real returns lower than equity, the real return assumption of 1.0% appears conservative, particularly relative to market forecasts for all absolute return assets (including long-short equity) of 5-6% nominal returns per annum. However, the 1.0% real return assumption is more in line with market forecasts for absolute return once long-short equity is removed and matches the 30% public equity, 70% cash return target for this asset class. UCIM deems it appropriate to assume a 2.75% alpha, in line with the "Cash + 400 basis points" target of this asset class, given its confidence in selecting managers capable of generating returns above the 30% public equity, 70% cash benchmark. The volatility of 6.5% is based on historical averages of volatility adjusted for the CUEF's preference for the lower beta absolute return classes.

[2] MSCI EM ex-China, IBOVESPA, MSCI EM.

Cash: After examining an array of market forecasts and historic data, UCIM believes 0.5% of outperformance of UK Gilts against cash is appropriate, thus arriving at a -0.25% cash real return assumption. UCIM assumes no alpha within its returns for this asset class, given the difficulty in consistently outperforming over long periods of time. The volatility assumption of 1.5% is consistent with the 20-year average historic volatility of high-quality short-term government instruments.

*Commentary on the assumptions used for sub-asset classes are provided in Appendix 2 below.*

Key assumptions on asset class correlations are shown in Figure 2 below. The correlations rely on a combination of forecasts and historic data, with convergence between economies resulting in equity correlation forecasts above historical values. Two major deviations from this method have been made to increase the alignment with CUEF's portfolio. First, UCIM assumed lower correlations between absolute return and equities, given the decision to exclude long-short investments from CUEF's absolute return and credit portfolio. Second, UCIM used a lower correlation between real estate and equities, given the CUEF does not invest in more correlated parts of this asset class such as REITs.

*Figure 2: 20-year forecast asset class correlations*

| Correlations | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Public Equity - US | 1.00 | 0.90 | 0.60 | 0.70 | 0.75 | 0.65 | 0.50 | 0.50 | 0.50 | 0.70 | 0.50 | 0.20 | 0.20 | 0.00 |
| 2. Public Equity - DM ex-US | 0.90 | 1.00 | 0.60 | 0.70 | 0.75 | 0.65 | 0.50 | 0.50 | 0.50 | 0.70 | 0.50 | 0.20 | 0.20 | 0.00 |
| 3. Public Equity - China | 0.60 | 0.60 | 1.00 | 0.70 | 0.55 | 0.50 | 0.25 | 0.30 | 0.40 | 0.50 | 0.40 | 0.10 | 0.10 | 0.00 |
| 4. Public Equity - EM ex-China | 0.70 | 0.70 | 0.70 | 1.00 | 0.60 | 0.55 | 0.25 | 0.40 | 0.50 | 0.60 | 0.40 | 0.10 | 0.10 | 0.00 |
| 5. PE - Buyout | 0.75 | 0.75 | 0.55 | 0.60 | 1.00 | 0.90 | 0.40 | 0.50 | 0.30 | 0.60 | 0.40 | 0.10 | 0.00 | 0.00 |
| 6. PE - VC and Growth | 0.65 | 0.65 | 0.50 | 0.55 | 0.90 | 1.00 | 0.35 | 0.40 | 0.30 | 0.50 | 0.30 | 0.10 | 0.10 | 0.00 |
| 7. Absolute Return | 0.50 | 0.50 | 0.25 | 0.25 | 0.40 | 0.35 | 1.00 | 0.50 | 0.30 | 0.50 | 0.40 | 0.10 | 0.10 | 0.00 |
| 8. Real Estate | 0.50 | 0.50 | 0.30 | 0.40 | 0.50 | 0.40 | 0.50 | 1.00 | 0.30 | 0.50 | 0.20 | 0.10 | 0.10 | 0.00 |
| 9. Natural Resources | 0.50 | 0.50 | 0.40 | 0.50 | 0.30 | 0.30 | 0.30 | 0.30 | 1.00 | 0.50 | 0.30 | 0.10 | 0.10 | 0.00 |
| 10. HY Corporate Bonds | 0.70 | 0.70 | 0.50 | 0.60 | 0.60 | 0.50 | 0.50 | 0.50 | 0.50 | 1.00 | 0.70 | 0.30 | 0.30 | 0.00 |
| 11. IG Corporate Bonds | 0.50 | 0.50 | 0.40 | 0.40 | 0.40 | 0.30 | 0.40 | 0.20 | 0.30 | 0.70 | 1.00 | 0.40 | 0.40 | 0.00 |
| 12. UK Inflation-Linked Bonds | 0.20 | 0.20 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.30 | 0.40 | 1.00 | 0.80 | 0.00 |
| 13. UK Government Bonds | 0.20 | 0.20 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.30 | 0.40 | 0.80 | 1.00 | 0.00 |
| 14. Cash | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |

Within its key Base Case assumptions, UCIM has considered the constraints dictated by liquidity needs and asset class risk limits to ensure the analysis is run in line with the internal guidelines and thresholds detailed in Appendix 1, agreed by the UCIM Board and reviewed by the Investment Advisory Board. In all optimisation scenarios, UCIM assumes the portfolio does not run with leverage as the threshold guideline assumes a 0% cash lower limit. In practice, the CUEF's revolving credit facility can be used, such as in times of market distress to bridge redemptions.

The Base Case assumes the portfolio could run at the risk limit thresholds rather than be restricted to internal guidelines (see Appendix 1), to avoid over-restricting the model to any desired output (the more restrictive scenario is one of three alternative scenarios tested). Notably, it allows the portfolio to be run with 55% illiquid assets, comprising just private equity and real assets for simplicity.

Finally, three possible CUEF allocations were assumed for the Base Case scenario. The "Current Allocation" is based on CUEF's asset class split as of 30th September 2022. The "Target Allocation" uses CUEF's long-term asset allocation targets agreed by the UCIM Board and reviewed by the

Investment Advisory Board (as set out in Appendix 1). The "Efficient Frontier Allocation" is the software-determined asset mix which maximises return for a similar risk level to the Current Allocation, subject to the CUEF's risk limit thresholds.

## Base Case Conclusions

Using the assumptions and constraints detailed above, the optimisation modelling suggests the Current Allocation of the CUEF could produce a 5.6% real geometric[3] return per annum with a 14.4% standard deviation.[4] Based on the Current Allocation and assumed alpha for each sub asset class, 1.6% of the return is from assumed alpha, indicating that it would not be possible to achieve the CUEF's 5.0% real return target with a more "passive" approach. Meanwhile, the Target Allocation implies a 5.8% real return per annum with a 14.5% standard deviation. These forecasts are above the 2021 exercise, a product of incorporating a modest level of alpha into UCIM's return estimates. That said, the asset optimisation exercise illustrates that achieving a 6.8% real geometric return with a similar level of risk to that of the Current or Target Allocation is theoretically possible at a 14.5% standard deviation. As shown in Figure 3, the potential Efficient Frontier Allocation should provide this greater return for similar risk levels by reducing public equity and increasing private equity, absolute return, and real assets.

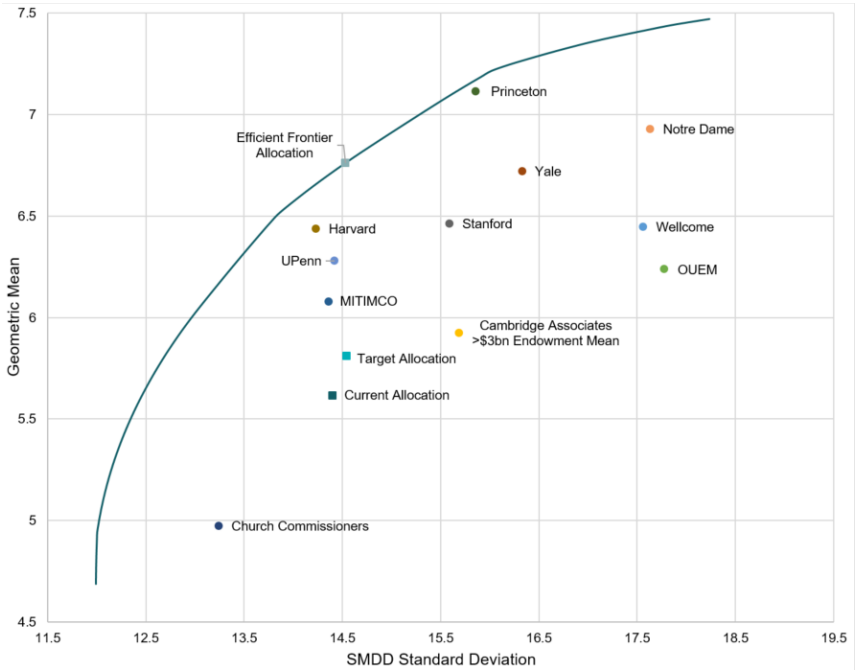
*Figure 3: Comparison of Current, Target, and Efficient Frontier allocations*

| Asset Class | Current Allocation | Target Allocation | Efficient Frontier Allocation |
|---|---|---|---|
| **Public Equity** | 41.0% | 40.0% | 15.0% |
| ***of which Developed Markets*** | *33.0%* | *30.0%* | *7.5%* |
| ***of which Emerging Markets*** | *8.0%* | *10.0%* | *7.5%* |
| **Private Equity** | 23.2% | 25.0% | 40.0% |
| **Absolute Return and Credit** | 20.3% | 20.0% | 25.0% |
| **Real Assets** | 7.8% | 10.0% | 15.0% |
| **Cash and Fixed Income** | 7.7% | 5.0% | 5.0% |

To provide further context, UCIM analysed several peer institutions' forecast return and volatility using their most recently disclosed asset allocation, generally 30th June 2022 (see a detailed table of asset allocations by institution in Appendix 3).[5] Figure 4 shows several peer institutions benchmarked against UCIM's efficient frontier. Almost all peers are forecast to achieve higher returns with commensurably higher risk than the CUEF's Current and Target Allocations, with the Church Commissioners a notable exception given a 24.1% allocation to real assets and 8.1% allocation to cash and fixed income, resulting in lower, more stable returns. That said, whilst peer group returns are higher than the CUEF's forecast Current and Target Allocation returns, nearly all remain below the efficient frontier. The Efficient Frontier peer group underperformance is likely a product of lacking sufficient diversifiers, particularly as private equity and venture capital have become outsized allocations in many portfolios due to a "denominator effect" as public market valuations have declined over 2022.

[3] The geometric mean considers compounding and is thus more appropriate for time series of financial returns.
[4] UCIM uses smoothed multivariate discrete distribution ("SMDD") standard deviation. This is common in mean-variance optimisation, as opposed to "conventional" standard deviation. For reference, the "conventional" standard deviations are 13.7%, 13.9%, and 13.8% for the Current Allocation, Target Allocation, and Efficient Frontier Allocation respectively.
[5] Where detailed asset allocation splits were not disclosed by the institution, UCIM has estimated based on available data.

*Figure 4: Efficient Frontier based on CUEF base case assumptions and constraints versus peers*




## Alternative Scenarios

UCIM has furthermore considered how each of the three allocations set out above (that is, the Current, Target, and Efficient Frontier) would perform in the following scenarios; first, the CUEF asset classes were only able to generate benchmark real returns; second, if the level of correlation between asset classes was higher; and, third, if the CUEF was subject to the more restrictive internal guideline risk limits detailed in Appendix 1. The results are summarised in Figure 5, with an overall conclusion that the Efficient Frontier should consistently offer higher risk-adjusted returns when compared with the Current and Target allocations.

The first scenario sees no alpha assumed, and thus returns equate to the asset class averages, with no other changes to correlation or standard deviation to isolate the impact. Although the Efficient Frontier allocation sees the largest deviation in forecast return, it remains the highest-performing allocation in this “No Alpha” scenario. The greater reduction is unsurprising given the increased allocation to private equity and absolute return and credit where UCIM believes its managers can generate the highest alpha. We are comfortable assuming a moderate degree of alpha given our access to high-quality managers and willingness to accept moderate idiosyncratic risk for long-run outperformance, as evidenced by the CUEF’s managers historically.

The second scenario reflects an environment in which correlations are higher, as in stressed scenarios. In this instance, returns and standard deviations were assumed unchanged. At the same time, all correlations were increased by 0.1 (other than the ones originally at or above 0.8, given higher correlation would introduce collinearity problems). As shown in Figure 5, in this “High Correlation” scenario, all three allocations have marginally lower returns, but meaningfully greater volatility. The Efficient Frontier Allocation remains the best-performing allocation in this scenario, offering greater forecast return for a similar risk level to the Current and Target Allocations given greater weights to less correlated asset classes of absolute return and credit and real assets.

In all previous scenarios, UCIM used the threshold risk limits. The "Tighter Constraints" scenario narrows the portfolio constraints to the internal guidelines as detailed in Appendix 1 to help identify which existing constraints are most restrictive. As shown in Figure 5, the Current and Target Allocations are unaffected as the asset allocations are well within the constraints. The highest forecast return achievable for a similar volatility level under the more onerous risk limits is 6.6%, with absolute return and credit, real assets, and private equity all at their upper guideline limit and a reallocation to public equities compared to other scenarios.

*Figure 5: Comparison of allocation outcomes under different scenarios*

| Scenario | Efficient Frontier Allocation | | Existing Target Allocation | | Current Allocation | |
|---|---|---|---|---|---|---|
| | Return | SD | Return | SD | Return | SD |
| **Base Case** | 6.8% | 14.5% | 5.8% | 14.5% | 5.6% | 14.4% |
| **No Alpha** | 4.8% | 14.5% | 4.3% | 14.5% | 4.1% | 14.4% |
| **High Correlation** | 6.7% | 15.0% | 5.7% | 15.1% | 5.5% | 14.9% |
| **Tighter Constraints** | 6.6% | 14.5% | 5.8% | 14.5% | 5.6% | 14.4% |

## Recommended Actions

UCIM will continue to evolve the endowment's asset allocation to "enhance long-term returns while simultaneously limiting volatility," as proposed in September 2019 to the Investment Advisory Board. While the Base Case Efficient Frontier allocation presented above is, in theory, an optimal allocation, it would require operating at the CUEF's illiquidity limit of 55%, as laid out in Appendix 1. While this scenario is possible, given the flexibility provided by CUEF's credit facilities, it is unlikely that UCIM would choose to manage the portfolio at such a level of illiquidity over a sustained period, given the lack of flexibility it would imply for the portfolio, for example, in the event of a large market drawdown.

Consistent with the asset optimisation exercise performed in 2021, this year's exercise has demonstrated the return advantages of increasing the allocation to private equity compared to public equity and increasing the allocation to absolute return and credit and real assets as a higher-returning diversifier. Two years ago, the CUEF was still quite far off its target asset allocation, and, as such, no change to the Target Allocation was deemed necessary at the time. Today, the CUEF's asset allocation is nearing the Target Allocation, raising the question of whether the Target Allocation should be adjusted toward the Efficient Frontier allocation.

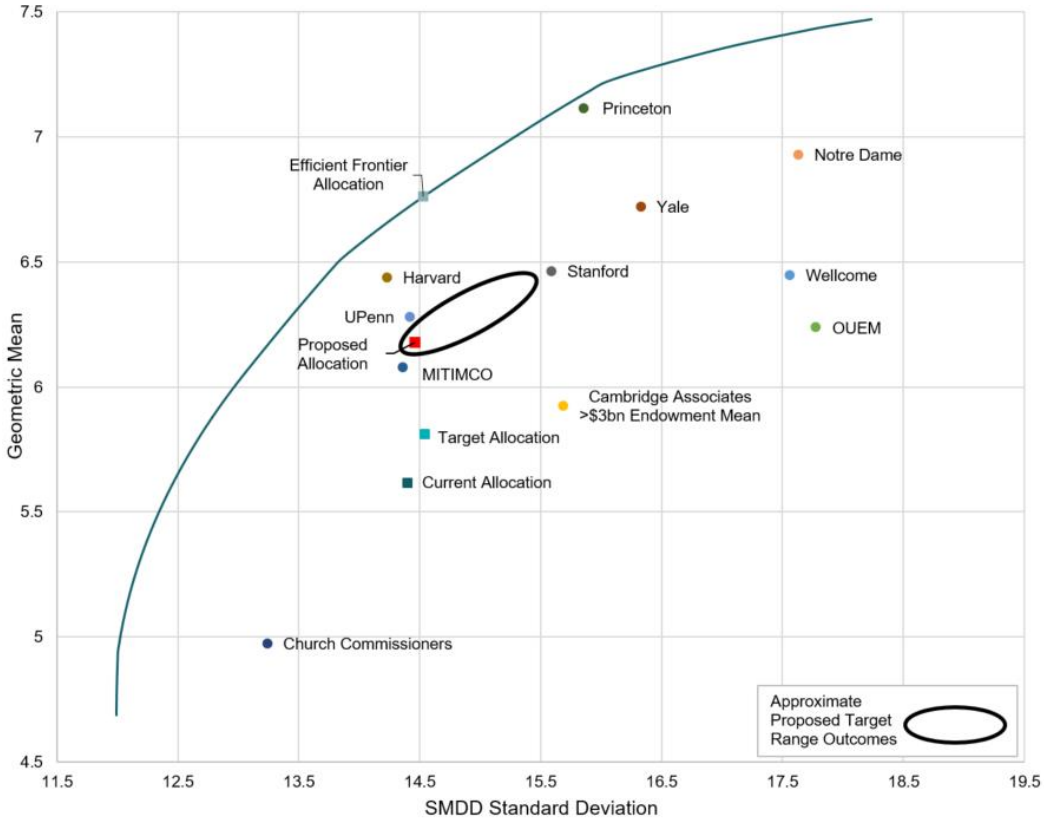
In light of this year's exercise, UCIM therefore recommends adjusting the CUEF's asset allocation targets, using proposed ranges over point targets, shown in Figure 6, to provide flexibility across the cycle to reallocate between equities and diversifiers. The "Proposed Allocation" assumes that public equities are at the bottom of the range and absolute return and credit, and real assets are at the upper end of the range. The UCIM Board was supportive of this recommendation and approved a change to the CUEF's asset class targets at the 3rd April 2023 meeting, subsequently reviewed and supported by the Investment Advisory Board.

*Figure 6: Comparison of Current, Target and Proposed Allocations*

| Asset Class | Current Allocation | Existing Target Allocation | Proposed Allocation |
|---|---|---|---|
| **Public Equity** | 41.0% | 40.0% | 30.0-35.0% |
| **Private Equity** | 23.2% | 25.0% | 30.0% |
| **Absolute Return and Credit** | 20.3% | 20.0% | 20.0-22.5% |
| **Real Assets** | 7.8% | 10.0% | 10.0-12.5% |
| **Cash and Fixed Income** | 7.7% | 5.0% | 5.0% |

The model suggests that using the Base Case assumptions, the CUEF's expected real return under the Proposed Allocation is 6.2% on average, compared to 5.6% and 5.8% for the Current and Existing Target Allocations, respectively. Compared to the Current Allocation, 1/3 of the forecast real return increase arises from an assumed alpha increase to 1.8%, as asset classes with greater dispersion and alpha potential make up a larger part of the CUEF portfolio. Over a 20-year time horizon, the Morningstar software forecasts that the Proposed Allocation has a 66.8% chance of achieving the 5% real return target compared to 59.6% and 61.5% for the Current and Existing Target Allocations, respectively. The potentially greater return is achieved with a forecast similar 14-15% standard deviation, as the increased allocations to absolute return and credit, and real assets offer diversification benefits that offset the tilt to higher risk-return assets within the CUEF's equity allocation. The use of a range in the Proposed Allocation reflects the intention of UCIM to opportunistically move across the risk-reward spectrum to take advantages of public equity dislocations or position the CUEF more conservatively, as shown in Figure 7 below.

*Figure 7: Efficient Frontier with Proposed Target allocation and range illustrated*



While this proposal would take the CUEF closer to the Efficient Frontier allocation, it increases the proportion of the fund considered illiquid. Under the proposed change to the target allocation, illiquid assets would increase from 35.0% of the CUEF to 40-42.5% of the CUEF, still meaningfully below the 50.0% internal guideline and 55.0% threshold risk limits as well as that of numerous peer investors. The proposal would not move any asset classes beyond the internal guidelines, although absolute return and credit and real assets would be close to guideline range.

UCIM will repeat the asset optimisation modelling exercise in 2025, although the exercise can be brought forward in the event of material changes in the long-term investment outlook. In the meantime, the team will continue to engage with like-minded peers to understand their thinking on how they balance their investments in less liquid asset classes, such as private equity and real assets, with the need to preserve liquidity for distributions to investors and redeployment around market corrections.

# Appendices

## Appendix 1: CUEF Portfolio Guidelines and Constraints

| Characteristic | Asset Class Targets | Internal Guideline | Threshold |
|---|---|---|---|
| Total Equities | 65% | 60-70% | 55-75% |
| Public Equity | 40% | <45% | <50% |
| Private Equity | 25% | <35% | <40% |
| Absolute Return and Credit | 20% | 17.5-22.5% | 15-25% |
| Real Assets | 10% | 7.5-12.5% | 5-15% |
| Cash and Fixed Income | 5% | 2-8% | 0-12% |
| Illiquid Assets | 35% | <50% | <55% |

## Appendix 2: Sub-Asset Class Considerations

Although UCIM approaches investments from a bottom-up perspective, the team is cognisant of the need to manage sub-asset class allocations. Within asset classes, UCIM manages sub-asset class allocations more tactically, considering the attractiveness of the opportunity set for each manager based on structural marketplace changes and valuations. For instance, although the exercise assumes a combined value for developed market public equity outside the US, there are clear economic, market, and demographic differences between the UK, continental Europe, and Japan. However, the limited granularity in available market forecasts and wide confidence intervals for any 20-year assumption meant disaggregating these was not deemed appropriate. Nonetheless, for asset classes with meaningfully different return and volatility drivers or roles in the portfolio, it is prudent to separate asset classes where possible given data constraints.

Alternative asset classes warrant significant allocation attention given their greater return dispersion, as shown in Figures 8 and 9 above. For example, historic data illustrate lower similar returns for venture capital and buyout within private equity, a product of the concentration of returns in venture capital. Consequently, although the high-level strategic proposed allocation combines these two asset classes, significant consideration will continue to be given to the sub-asset class allocations.

Three sub-asset class restrictions were added to reflect informal risk limits beyond which the UCIM team would not run sub-asset class allocations. These were a 50% limit on emerging market equities within the public equity asset allocation, a limit within private equity that neither buyout nor venture capital and growth could exceed 75% of that asset class, and a 2% overall lower bound on cash.

Real Estate: The real return assumption of 2.5% is primarily based on the forecasts for “core-plus” real estate which has historically returned 5-6% nominal per annum. The assumption is in line with the role of the asset class in the CUEF portfolio, which is to provide a lower-risk source of diversification with manager selection value to generate closer to “value-added” style returns without taking on such a level of risk. Consequently, a 1.5% alpha was forecast based on the market forecast average return differential between value-added and core-plus managers. The 11.0% volatility assumption is based on the average market forecast of 11.4% for real estate, adjusted marginally downwards after excluding outliers such as low volatility core diversified real estate or highly levered value-added real estate.

Natural Resources: The 3.0% real return assumption reflects the fact that this is a heterogeneous group of assets including, but not limited to, infrastructure, commodities, timber, and renewable

energy. Although different factors drive the returns of each sub-asset class, they serve the similar purpose of offering relatively uncorrelated returns, which can be beneficiaries of inflation. Forecasts for returns on these sub-asset classes range from 3.0% to 8.4% nominal. UCIM has taken a simple average of forecast returns for the sub-asset classes in which the CUEF might invest (excluding, for example, conventional energy) and applied an illiquidity premium to reflect the vehicles through which the CUEF accesses such investments. The 1.0% alpha is based on the UCIM's willingness to work with control-oriented managers to add value to assets, thus generating outsized returns in a generally commoditised market. The volatility forecast of 15.0% is adjusted below the average market forecast of 17.3%, given the CUEF skews toward lower-risk assets, such as farmland or renewable platforms, whereas forecasts are largely public commodities, including single resources such as crude oil.

High-Yield Corporate Bonds: The real return assumption of 3.0% takes the 35-year historical nominal return average of 5.4% and adjusts it to reflect the current yield-to-maturity ("YTM")[6] of available high-yield bond indexes and forecast default rates, before adjusting for inflation. We assume no alpha given it is difficult to generate consistent outperformance over the long term. The volatility assumption of 9.5% is based on a 40-year historical range between 8.0% and 10.0%.

Investment Grade Corporate Bonds: The annual real return assumption of 1.5% is based on the average nominal return since 1987 of 4.4%, adjusted for the current YTM of relevant indices, assumed default rates, and our forecast inflation. UCIM has assumed no alpha given it is very difficult to generate consistent and meaningful outperformance investing in investment grade corporate bonds. The volatility assumption of 6.0% is based on the historical range since 1987.

UK Inflation-Linked Bonds: The 0.25% real return is based on the 20-year index-linked curve for the UK currently priced at 0.25% YTM.[7] UCIM assumes it will be unable to generate alpha in this sub-asset class. The volatility assumption of 5.0% is based on the market forecasts for developed market inflation-linked bonds.

UK Government Bonds: The 0.25% real return assumes that return arbitrage between inflation-linked bonds and government bonds is not possible and thus returns are equal. UCIM assumes it will be unable to generate alpha in this sub-asset class. The volatility assumption of 5.5% is based on 10-20-year data and market forecasts for broader developed market government bonds.

[6] The YTM is the internal rate of return on a bond held to maturity assuming no default.
[7] Calculated using 20-year UK Inflation Linked Curve (Bloomberg Ticker: YCGT0098).

*Figure 8: Cambridge Associates average annual manager returns and dispersion by asset class*[8]

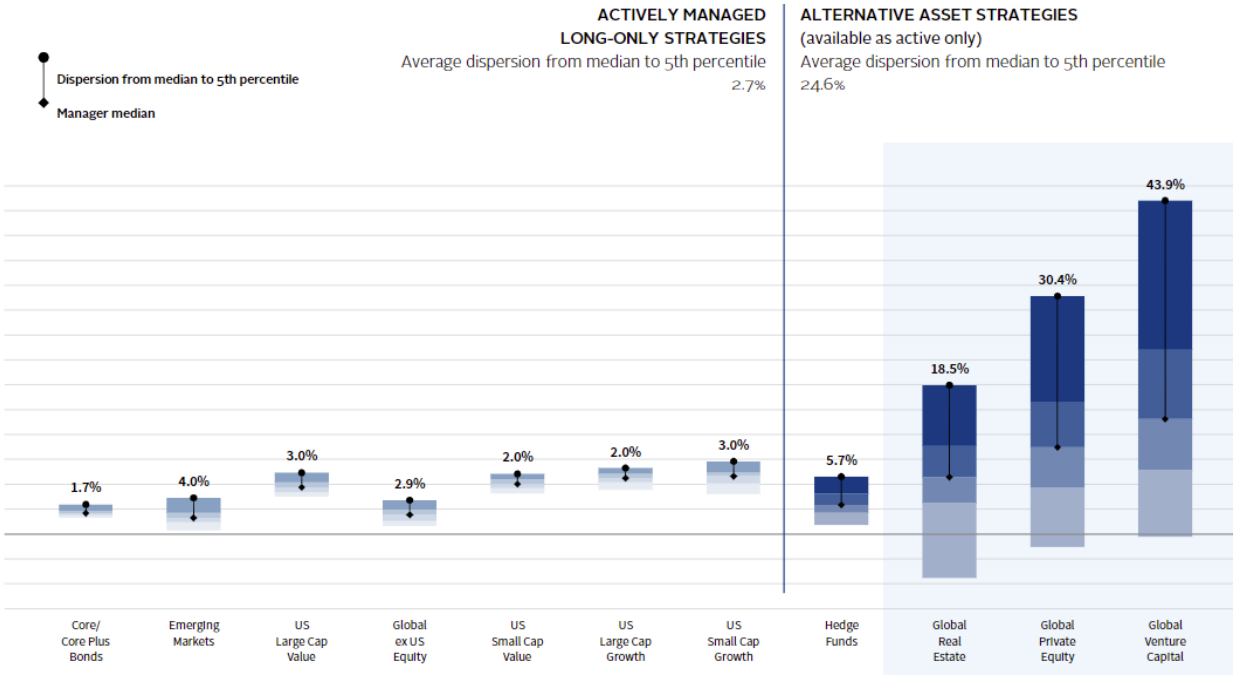



*Figure 9: CAIS Group average annual manager returns and dispersion by asset class*[9]

[8] Source: Cambridge Associates. Data from 1st January 2008 to 31st March 2022.
[9] Source: CAIS Group. Excluding funds in the 2.5% return tails of each asset class depicted. Hedge funds were done using constituents of the HFRI Composite since 1990. Private equity, private debt, and real estate and infrastructure data was from Preqin, represented by mature funds (minimum 10 years other than for secondaries which was minimum seven years and private debt sub-asset classes with minimum three years). Fixed income and public equity funds were represented by US focused open-end funds from Bloomberg. Using 10-year annualised total returns.

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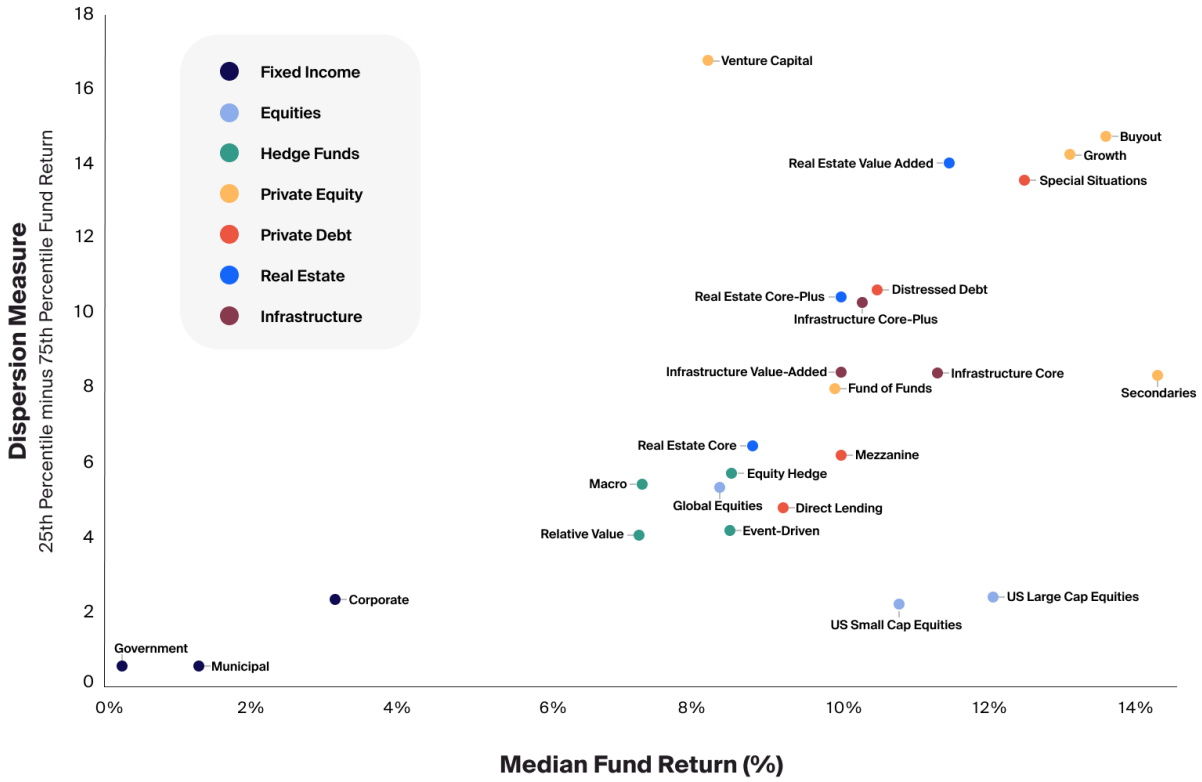

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## Appendix 3: Endowment and Foundation Peer Asset Allocations

| Asset Class | Current Allocation | Target Allocation | Yale | Stanford | Harvard | MITIMCO | Princeton | UPenn | Notre Dame | Wellcome | CA >$3bn Endowment Mean | Church Commissioners | OUEM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| as of | 21/03/2023 | NA | 30/06/2022 | 30/06/2022 | 30/06/2022 | 30/06/2022 | 30/06/2022 | 30/06/2022 | 30/06/2022 | 30/09/2022 | 30/09/2022 | 31/12/2021 | 31/12/2021 |
| **Public Equity** | **41.0%** | **40.0%** | **20.1%** | **25.0%** | **22.3%** | **20.4%** | **15.1%** | **20.9%** | **23.0%** | **40.3%** | **39.1%** | **42.7%** | **39.5%** |
| **Public Equity – Developed Markets** | **33.0%** | **30.0%** | **16.0%** | **20.8%** | **13.6%** | **18.9%** | **7.9%** | **14.5%** | **20.5%** | **33.0%** | **32.3%** | **34.0%** | **35.0%** |
| Public Equity – US | 18.9% | 20.0% | 8.0% | 8.0% | 9.4% | 8.1% | 3.9% | 8.5% | 10.6% | 16.5% | 16.8% | 17.0% | 17.5% |
| Public Equity – DM ex-US | 14.1% | 10.0% | 8.0% | 12.8% | 4.2% | 10.8% | 3.9% | 5.9% | 9.9% | 16.5% | 15.5% | 17.0% | 17.5% |
| **Public Equity – Emerging Markets** | **8.0%** | **10.0%** | **4.1%** | **4.3%** | **8.6%** | **1.5%** | **7.2%** | **6.5%** | **2.5%** | **7.3%** | **6.8%** | **8.7%** | **4.5%** |
| Public Equity – China | 3.4% | 4.0% | 2.0% | 2.1% | 4.3% | 0.8% | 3.6% | 3.2% | 1.2% | 3.7% | 3.4% | 4.4% | 2.3% |
| Public Equity – EM ex-China | 4.6% | 6.0% | 2.0% | 2.1% | 4.3% | 0.8% | 3.6% | 3.2% | 1.2% | 3.7% | 3.4% | 4.4% | 2.3% |
| **Private Equity** | **23.2%** | **25.0%** | **43.3%** | **37.0%** | **34.1%** | **33.9%** | **44.0%** | **35.2%** | **48.6%** | **37.1%** | **27.7%** | **12.2%** | **37.8%** |
| Private Equity – Buyout | 13.4% | 17.5% | 19.1% | 16.7% | 15.3% | 15.2% | 19.8% | 15.8% | 21.9% | 16.9% | 12.3% | 6.6% | 17.0% |
| Private Equity – VC and Growth | 9.8% | 7.5% | 24.2% | 20.4% | 18.7% | 18.6% | 24.2% | 19.4% | 26.7% | 20.2% | 15.4% | 5.6% | 20.8% |
| **Absolute Return and Credit** | **20.3%** | **20.0%** | **16.5%** | **22.5%** | **33.9%** | **20.4%** | **28.4%** | **22.3%** | **16.5%** | **6.5%** | **18.3%** | **12.9%** | **10.9%** |
| Absolute Return | 20.3% | 20.0% | 11.4% | 18.0% | 29.7% | 15.4% | 24.4% | 19.3% | 13.9% | 6.5% | 9.6% | 8.7% | 0.0% |
| High Yield Corporate Bonds | 0.0% | 0.0% | 2.5% | 2.3% | 0.5% | 2.5% | 2.0% | 1.9% | 1.3% | 0.0% | 2.7% | 2.1% | 5.5% |
| Investment Grade Corporate Bonds | 0.0% | 0.0% | 2.5% | 2.3% | 3.8% | 2.5% | 2.0% | 1.1% | 1.3% | 0.0% | 6.0% | 2.1% | 5.5% |
| **Real Assets** | **7.8%** | **10.0%** | **12.8%** | **11.0%** | **5.6%** | **16.9%** | **11.6%** | **11.7%** | **3.5%** | **7.8%** | **11.2%** | **24.1%** | **4.5%** |
| Real Estate | 4.8% | 7.0% | 8.5% | 7.3% | 4.8% | 16.2% | 7.7% | 6.6% | 2.3% | 7.8% | 5.5% | 17.5% | 3.0% |
| Natural Resources | 3.0% | 3.0% | 4.3% | 3.7% | 0.8% | 0.7% | 3.9% | 5.1% | 1.2% | 0.0% | 5.7% | 6.6% | 1.5% |
| **Cash and Fixed Income** | **7.7%** | **5.0%** | **7.4%** | **4.5%** | **4.2%** | **8.4%** | **0.9%** | **9.9%** | **8.4%** | **8.2%** | **3.7%** | **8.1%** | **7.3%** |
| Cash | 7.0% | 3.0% | 3.7% | 2.3% | 2.2% | 1.3% | 0.5% | 6.1% | 0.0% | 4.1% | 1.6% | 4.1% | 2.6% |
| UK Inflation-Linked Government Bonds | 0.0% | 1.0% | 0.0% | 0.0% | 1.9% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.0% |
| UK Government Bonds | 0.7% | 1.0% | 3.6% | 2.3% | 0.1% | 7.0% | 0.5% | 3.8% | 8.4% | 4.1% | 1.6% | 4.1% | 4.7% |