Optimising private market asset allocations

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Executive summary

In this paper we examine the integration of private market assets within traditional asset allocation strategies to assess performance impacts across investor risk profiles.

We believe that including private market assets can significantly enhance portfolio returns for investors who adopt a risk-based utility-maximising strategy in portfolio construction. Additionally, we find that unlisted infrastructure has the most potential of the private market assets considered to improve portfolio Sharpe ratios, especially for 'Defensive' and 'Balanced' investors.

Our research applies a utility maximisation framework which facilitates risk appetite aware optimisation to tailor portfolios to match specific investor risk preferences and lifecycle stages.

A novel two-stage returns unsmoothing approach is used to more accurately estimate true private market return volatility. We show that even after returns unsmoothing, private markets can significantly enhance portfolio outcomes.

This study finds that defensive investors benefit from allocations to infrastructure and private credit, achieving lower volatility and higher returns. Balanced investors see similar advantages with a stable allocation to infrastructure, while growth investors lean towards private equity for higher risk-reward profiles.

This analysis adds further weight to our assertion that private market assets have a material role to play in optimising investor portfolios.

1. The motivation

Our publication series has focused on the potential benefits that private market asset classes – and specifically unlisted infrastructure[1] – may contribute from a portfolio perspective. We continue to build a body of empirical evidence supporting greater allocation to private market assets for those investors who find themselves relatively underweight these asset classes, with the objectives of enhancing portfolio 'robustness' and improving overall risk-adjusted returns. This assertion is becoming well-accepted by investors as a key tenet of portfolio construction. This is particularly true in the post-pandemic investment environment, which is characterised by heightened geopolitical tension, the tide of megatrends and secular shifts in the economic environment. These risks are of increasing focus for investors given their potential to prompt unanticipated swings in the economic cycle and the investment environment.

The interaction of the economic cycle and private market asset returns was the focus of our most recent paper , where we found that private market assets can provide a degree of insulation from the economic cycle while also providing a hedge against inflation.

This paper seeks to build on previous work by examining private market asset allocations directly to optimise broad portfolio objectives.

1.1 The approach

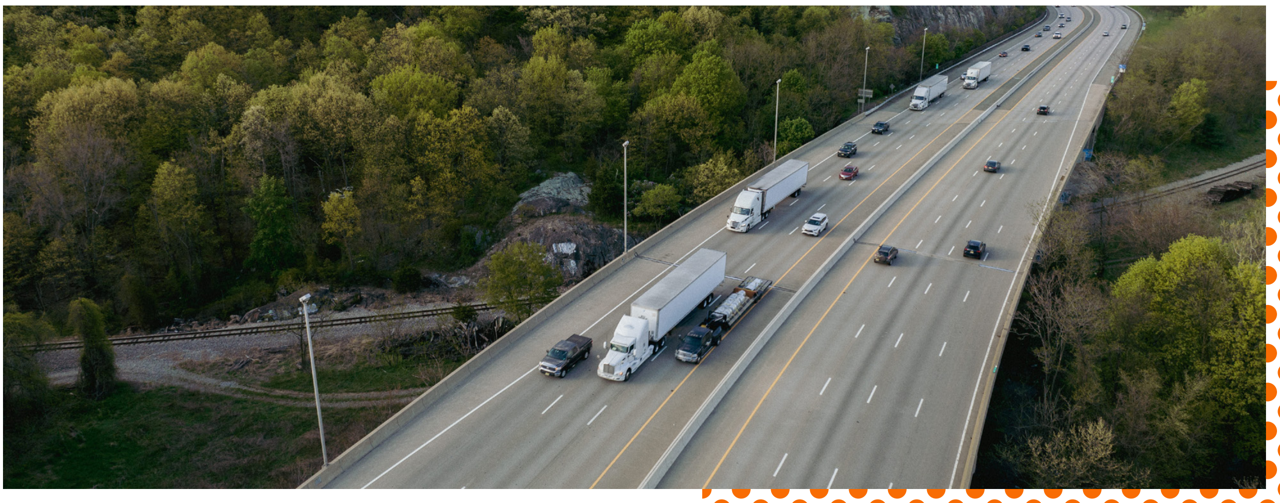
We investigate the optimal allocation of private assets that 'undiversified'/listed market investors should add to their portfolios. In doing so we make a distinction between investor risk appetites and seek to identify private asset allocations appropriate for them and which complement their existing listed exposures.

In this sense our framework uses a total portfolio approach (TPA) – we optimise the risk-adjusted returns of the overall portfolio and not necessarily within individual asset class buckets. This is particularly important given the distinct characteristics of private market assets and the interaction they have with each other and with a portfolio composed only of public market assets. This paper seeks to apply the TPA framework to explore these relationships and assist the investor in positioning their strategic asset allocation to achieve long-term objectives.

1.2 The method

We introduce several innovations to our methodology, which, at its core, leverages Markowitz' Modern Portfolio Theory (MPT). The themes of diversification, correlation, efficiency and robustness are the foundations of the framework, which seeks to identify strategies to improve risk-adjusted returns. We do this in the knowledge that this framework is challenged by the inclusion of private market assets into a largely public market investment universe. The analytical critique in doing so is well-known including, but not limited to, differing returns distributions (Gaussian or not) and correlation dynamics, valuation styles and measurement of risk and liquidity. In this paper we seek to improve upon the bulk of the extant literature (including our own) by taking steps to address these critiques in a number of ways:

Utility maximisation: to better reflect real world portfolio construction approaches, we step away from the traditional Sharpe ratio maximisation approach and we leverage a utility maximisation framework. The primary difference is that the former assumes identical risk appetite/aversion across investors, whereas the latter recognises heterogeneous investor risk preferences.



[1] Evolving portfolios for the new paradigm: the case for private infrastructure (2023)

[2] Building robust portfolios with private assets: the importance of macro alpha and beta (2024)

Utility maximisation therefore allows us to examine optimal portfolio allocations across a range of risk appetites, from maximally defensive to pure growth and everything in-between. This also better approximates how portfolio allocation decisions are made in practice (see Technical Box 2 for a more detailed examination of this utility maximisation framework). Utility maximisation allows us to consider the objectives of different types of investors. For example, in the pension fund space investment objectives for members in the accumulation phase will be quite different to those in the pension phase.

Two stage unsmoothing: we build on our learnings from our previous missives by applying a novel two-stage return unsmoothing approach (based on two established approaches in the academic literature, see Technical Box 1 for a more detailed explanation) to the private market assets universe to better capture smoothing stemming from illiquidity impacts and various other sources. This results in a dramatic improvement in the comparability of private markets to listed markets.

This process highlights IFM Investors's infrastructure asset classes are much less impacted by returns unsmoothing than other private market assets considered. The implication being that this asset class shows evidence of having a relatively low illiquidity exposure for a private market asset (again this outcome is detailed in Technical Box 1).

Reduction in benchmark selection impact: the asset classes we consider are proxied by a large number of benchmarks including 61 series spanning both private (33 benchmarks) and public (28 benchmarks) markets – the former having returns 'unsmoothed'. Broad asset classes included are investment-grade (IG) fixed income, sub-IG fixed income/credit, listed equities, commodities, private credit, private equity, private real estate, and unlisted infrastructure.

The large number of benchmarks considered is important. This is because our methodology seeks to describe the characteristics of the asset class as a whole, rather than a single benchmark. By using multiple differentiated benchmarks within each asset class, we increase the flexibility of the algorithm such that the final allocations are better able to capture systematic asset class behaviour rather than risk capturing benchmark-specific idiosyncratic movements.

We also impose a constraint within the asset class that limits the investor to a maximum allocation of 40% to any single benchmark[3]. This is a nod to real world investor behaviour that seeks to diversify intra-asset class allocations where possible. Taking this approach serves to reduce the sensitivity of the results to benchmark selection, which can be substantial (and potentially self-serving).

Improving robustness of estimations: We seek to address a key short-coming of mean-variance optimisation that sees outlier observations disproportionately skew parameter estimates, leading to portfolios that are neither stable nor realistic. To achieve this, we apply a statistical shrinkage technique that has strong theoretical and empirical underpinnings to support its use (Ledoit & Wolf (2004a), Ledoit & Wolf (2004b)) to the estimation of key parameters to reduce the impact of 'noisy' sample data.

Finally, we also utilise a bootstrap resampling technique to both assess the variability of our portfolio optimisation results and to improve the robustness of model-suggested optimal allocations.

The combined impact of these innovations, we believe, yields more robust and intuitive results and allows the direct comparison of listed and private markets across a range of risk appetites.

1.3 Key findings

The following is a summary of our key findings[4]:

1. **Positive impact of private markets:** We believe that including private market assets can significantly enhance portfolio returns for undiversified utility-maximizing investors across the risk spectrum.

2. **Optimal portfolio composition:** We identify the historical private market portfolio composition to optimise utility across investors with varying risk appetites. There is a strong role for unlisted infrastructure and private credit for more risk averse investors but a stronger role for private equity for investors with a greater risk appetite.

3. **Role of unlisted infrastructure:** We find that unlisted infrastructure has the most potential to improve portfolio Sharpe ratios, especially for 'Defensive' and 'Balanced' investors.

4. **Enhanced performance with IFM's UIP[5]:** The inclusion of IFM's Unlisted Infrastructure Proxy (UIP) can further enhance portfolio performance, leading to a greater tilt towards unlisted infrastructure for all levels of investor risk appetite.

[3] Note that this weight is applied to the listed and private portfolios separately. For example, if the portfolio is 70% listed and 30% private, then the maximum allocation to a single listed asset is 70%×40%=28% of the total portfolio, and the maximum allocation to a single private asset is 30%×40%=12% of the total portfolio.

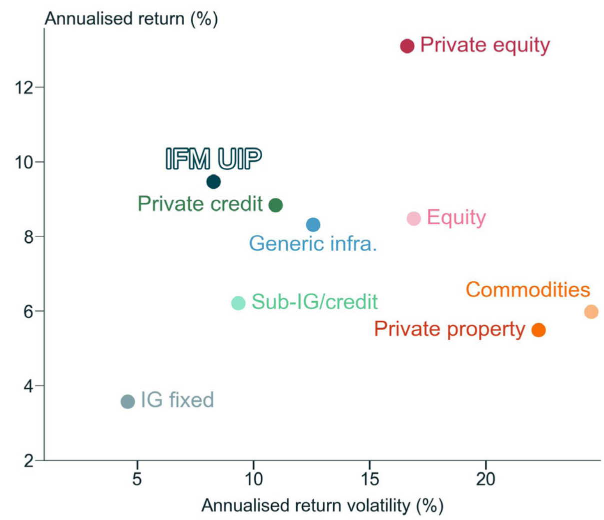
[4] The conclusions we draw throughout this paper are in the context of our modelling framework which is based on historical data analysis. We do not assert that these relationships will hold in the same way in future and seek only to inform the reader on this basis.

[5] In this article we define IFM's UIP to mean "Unlisted Infrastructure Proxy". Note that the limited benchmark universe within the unlisted infrastructure asset class can serve to 'penalise' performance compared with other asset classes that comprise more benchmarks where the optimisation algorithm is more 'forgiving' of underperformance. As a result, IFM created a proxy benchmark to demonstrate what it believes is representative of global unlisted infrastructure by combining the net local currency returns of two core infrastructure portfolios it manages.

2. Asset return overview

Due to the analytical approach undertaken our data universe is wider than in previous papers. We gather private market data from recognised private market providers Burgiss, Preqin, and MSCI, as well as IFM's own infrastructure portfolios. Listed market data are sourced from Bloomberg. As noted above our unsmoothing technique sees us utilise several private market benchmarks within each asset class for the estimation of unsmoothing parameters. The data window is limited by IFM's UIP performance history and the lagged nature of private market data and includes 79 quarterly return observations from Q4 2004 to Q2 2024. All data are detailed in the Data Appendix.

GRAPH 01 **AVERAGE ASSET CLASS RISK/RETURNS**



Source: IFM Investors, Bloomberg, Burgiss, MSCI

Graph 01 compares the average risk-return characteristics of each 'unsmoothed'[6] asset class over the entire window. It is important to note that there can be substantial differences in the performance of the different assets within a given asset class so this graph is intended only to provide a very high-level overview of how the assets perform on average.

Nonetheless the risk/return profile is broadly as we would expect as an investor accepts higher volatility of returns. That is to say takes more 'risk'[7]. It is notable that private markets assets tend to be found to the left of their listed counterparts even after the unsmoothing process. That is to say, private markets still tend to exhibit lower volatility for a given return. The notable outlier is private property where returns are uniquely at the centre of two crisis periods: the Global Financial Crisis (re-financing, securitisation and credit issues as well as economic impact); and the Global pandemic (public lock downs, changing work arrangements, impact on occupancy, supply-side inflation and rising rates). These high impact episodes punctuate returns for commercial property and impart a differentiated risk profile when compared to other private market asset classes.

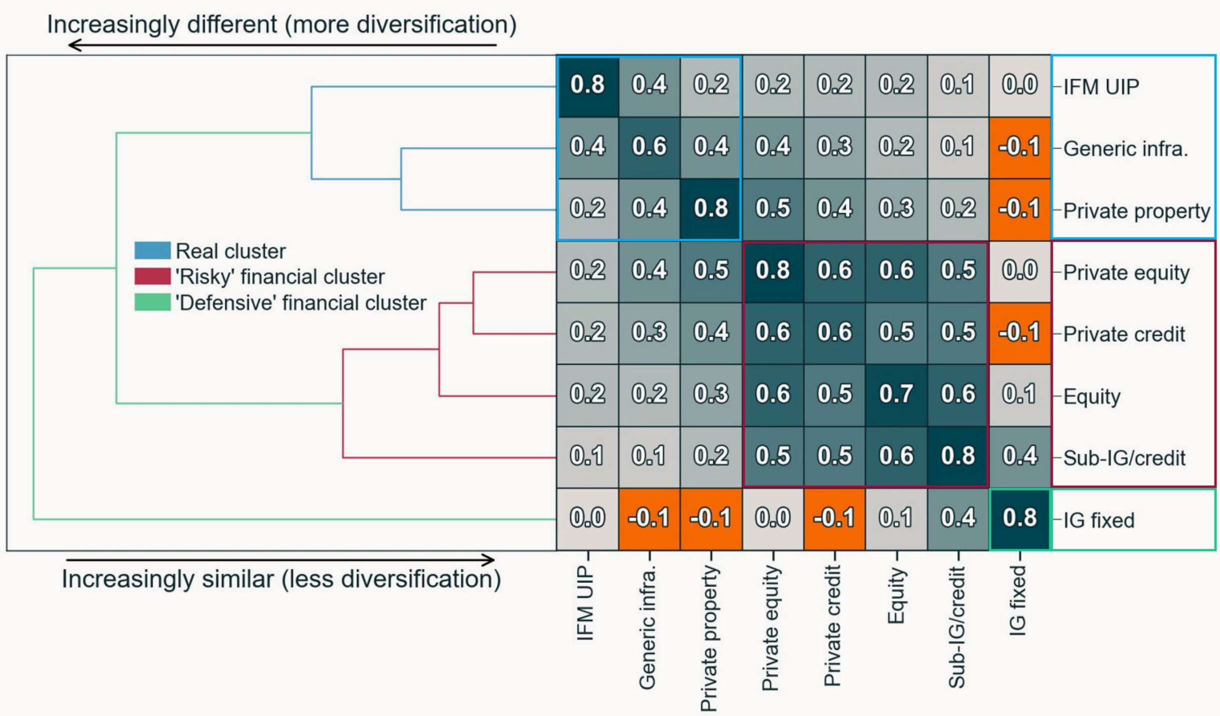
Graph 01 is a well-known method of highlighting risk-return characteristics of single assets or in this case asset classes. But we can also begin to examine the impact on a portfolio of these asset classes through the prism of correlation and co-movement. Noting that if all assets in a portfolio are too highly correlated, then diversification benefits will be eroded. We do this by applying machine learning techniques[8] – specifically a hierarchical clustering algorithm – to examine the degree of differentiation afforded by each asset class.

[6] We unsmooth the private market data are using a novel two-step approach that is detailed in Technical Box 1. Unsmoothing means a small number observations are lost, depending on the degree of returns smoothing. In this case four quarterly observations are lost and there are 75 quarterly return observations. This does not effect the conclusions drawn.

[7] We have written before and recognize here again that the term 'risk' isn't all encompassing, particularly for private market assets, and is descriptive of the volatility of returns.

[8] Using machine learning for this analysis is viewed as optimal because it offers flexibility, adaptability, scalability, and the ability to uncover complex patterns in financial data. While traditional methods provide valuable insights, ML techniques can capture more nuanced relationships, adjust dynamically to changing market conditions, and scale to handle larger and more complex datasets.

GRAPH 02 COMPARING PUBLIC AND PRIVATE ASSET RETURN CO-MOVEMENT BEHAVIOUR



Source: IFM Investors, Bloomberg, Burgiss, MSCI

Graph 02 shows the results of this analysis in a dendrogram paired with an ordered correlation matrix[9] - two closely related concepts. In the dendrogram, how far to the right various clusters split is important – the further to the right a split, the more similar is the co-movement of each asset, and this will tend to also be reflected in higher correlation coefficients. What can be identified is three broad clusters: 'real assets', 'risky' financial assets, and 'defensive' financial assets. These clusters are identified as being substantially different in terms of return co-movement. These clusters can be seen in the ordered correlation matrix and are highlighted by the coloured boxes. The 'real asset' cluster is substantially different from both the risky and safe financial asset cluster. There are several key takeaways from this:

- IG fixed income is a differentiated asset class from its equity and higher risk fixed income counterpart. This differentiation underpins the concept of the 60:40 portfolio.
- Sub-investment grade fixed income returns are more similar, in terms of returns co-movement, to 'risky' financial assets than to IG fixed income. And private credit and private equity returns exhibit an even higher degree of similarity. What these sectors have in common is that they are highly linked to economic cycles. That said the magnitude of returns and volatility are quite different (as shown in Graph 01). Private credit being in the 'risky' financial asset cluster highlights it as distinct from the other private market assets classes considered.
- The real asset cluster, despite being equity-based, exhibits fewer similarities to private and public equity, clearly implying that not all equity is the same. Indeed, sub-IG corporate debt tends to be more similar to equity than real assets are, understandably so as returns of a company are linked in the way they flow to either equity or debt investors. Like fixed income, real assets are clearly a portfolio diversifier.
- Interestingly, IFM's UIP exhibits less co-movement in the real asset cluster than generic unlisted infrastructure and unlisted property. This implies that unlisted infrastructure portfolio management may have a material impact on the diversification benefit of an asset class.

[9] Note that the correlations in the diagonal are not one – as is usually the case – because we are averaging the correlations within each asset class.

3. Portfolio estimation

3.1 Setting the scene

The overview of asset class returns has important implications for optimising the portfolio construction that underpins the modelling framework. Our portfolio modelling objective is to identify utility-maximising portfolios across the risk spectrum ranging from maximally defensive to pure growth.

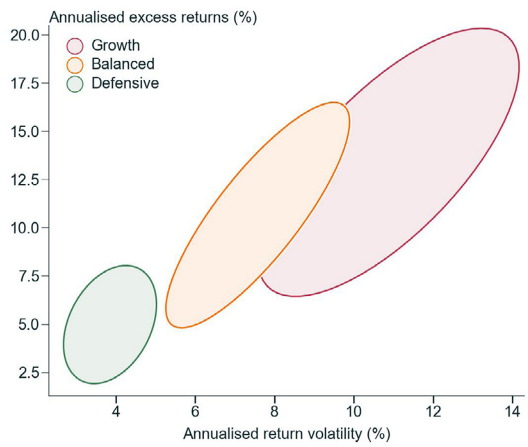
The modelling approach is outlined in depth in Technical Box 2. It is applied in two stages:

1. Firstly, to identify the optimal utility maximising portfolios constructed from only listed assets (IG fixed, Sub-IG/credit, equities, commodities) which we will refer to as the 'listed optimal' portfolio.

2. Secondly, to identify the optimal utility maximising portfolios constructed to include private market assets. We impose an upper limit on the allocation to private markets of 30% (private equity, private credit, private property, unlisted infra) which we will refer to as the 'enhanced optimal'.

We impose some additional constraints on particular asset class allocations to prevent over-concentration. Specifically, we limit Sub-IG/credit and commodities to a maximum of 30% and 15%, respectively, of the public/listed portfolio allocation. We also limit the maximum allocation to a single asset to 40% to prevent overly concentrated positions that would potentially not be reflective of reality, particularly for private market assets. With these constraints in place our simulation takes 1,000 samples across 29 different points across the risk spectrum (for a total of 29,000 portfolios).

GRAPH 03 **RISK/RETURN FOOTPRINTS OF DIFFERENT LISTED PORTFOLIO INVESTMENT APPROACHES**



Source: IFM Investors, Bloomberg, Burgiss, MSCI

3.2 The undiversified portfolio

In this utility maximising framework, we define and consider three 'representative' investor 'types', one at either end of the risk-return spectrum and one in the middle. We employ the concept of 'revealed preferences' (inferring investors' preferences and the models they use for making investment decisions based on their actual behaviour in the market) to estimate for each a starting listed only portfolio defined by their risk appetite. Specifically, a:

- **Defensive investor** has 80% of their allocation to 'defensives'.

- **Balanced investor** has 50% of their allocation to 'growth' assets and 50% of their allocation to 'defensives'.

- **Growth investor** has 80% of their allocation to growth assets.

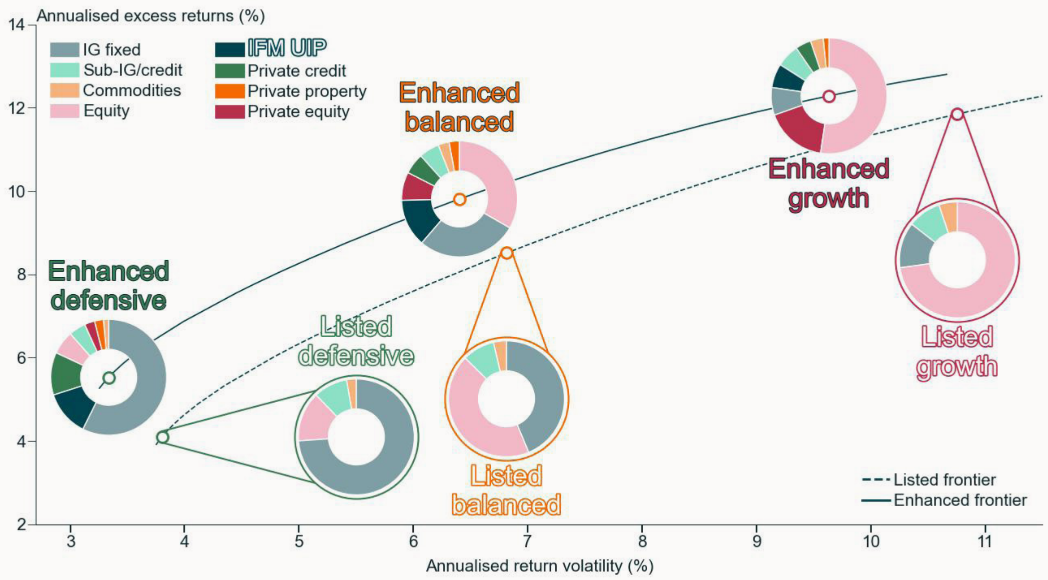
We sort assets into 'growth' and 'defensive' buckets by their historical risk profile[10]. This allows us to examine how a representative investor with a given risk appetite should have historically invested to maximise their portfolio utility.

To confirm this behavioural assumption in Graph 03 we construct some indicative returns-risk/volatility analysis for each investor portfolio using standard deviations and correlation of the underlying assets. But here we replace the more recognised point estimates with ellipses that show the risk/return 'footprint' for each portfolio based on our bootstrapped samples. Compared to the traditional single-point risk/return scatter chart, this approach carries more information and allows the visualisation of estimated parameter instability. This is to acknowledge that the underlying parameter relationships underpinning this portfolio construction are inherently unstable.

The portfolios come in broadly as would be expected. Growth investors have a much larger footprint for their returns as is defined by their risk appetite. Defensive investors the opposite. Two interesting observations can be made. The Balanced investor portfolio can potentially achieve outcomes in the Growth investor space (the ellipses overlap). But neither can achieve the outcomes of a Defensive investor. This supports the conclusion garnered from Graph 02 that investment grade fixed income assets provide a distinct and relatively unique risk return profile that cannot be replicated by other listed, or indeed unlisted, asset classes in this analysis. Noting the defensive portfolio is around 75% invested in IG fixed income.

[10] In terms of the risk profile of the individual asset classes we define IG fixed income as 100% defensive, Sub-IG/credit as 50% growth/50% defensive, equities as 100% growth, and commodities as 50% growth/50% defensive (Note that commodities include counter-cyclical commodities like agricultural products and precious metals as well as pro-cyclical commodities like petroleum and industrial metals).

GRAPH 04 UTILITY MAXIMISATION FRONTIER



Source: IFM Investors, Bloomberg, Burgiss, MSCI

We take the optimal portfolio for each investor in this analysis and place them on the risk-return frontier contained in Graph 04. Also on this graph are the three portfolio asset allocations comprising of only listed asset classes. The results for both are broadly as expected for each investor to achieve their objectives, the:

- **Defensive investor** is heavily invested in IG fixed income with around 75% allocation to this asset class – limiting the impact of shifting economic circumstances on the portfolio. The remainder of the portfolio is in asset classes exposed to economic growth, most notably equity and credit.
- **Balanced investor** has an almost equal allocation to IG fixed income and equity but still similar allocations to the credit and commodities spaces as the defensive investor.
- **Growth investor** is heavily invested in equities and leveraging into the economic cycle. Diversification in this portfolio is predominantly via IG and sub-IG fixed income.

Broadly, investors with a higher risk appetite accept lower Sharpe ratios for the opportunity of exceptional gains, prioritising potential high returns over risk-adjusted performance.

3.3 The diversified portfolio

Given these starting portfolios the question becomes: How does a maximum allocation of 30% to private market assets improve the risk adjusted returns profile of each investor, while still aligning with their respective levels of risk appetite?

It is immediately evident on Graph 04 that the utility maximising frontier moves up and to the left with all portfolios benefiting from this allocation shift. Each investor portfolio generates better excess returns (over the risk-free rate that we define as cash in our analysis) with a lower level of return volatility – that is to say, a higher Sharpe ratio. This asset allocation mix is, importantly, unique for each investor as follows:

- **Defensive investors** remain heavily invested in IG fixed income but there are now sizeable allocations to unlisted infrastructure[11] and private credit, the more defensive of the private market assets classes. And smaller allocations to the more risky private equity and property. There is less reliance on IG fixed income for its defensive properties yet the volatility of returns is reduced.
- **Balanced investors** have an even higher allocation to unlisted infrastructure (slightly more so than the defensive investor), but a reduced exposure to private credit, in favour of private equity, than the defensive investor. Allocations to property and commodities are slightly increased.
- **Growth investors** have a lower allocation to unlisted infrastructure than their more risk averse counterparts, being tilted towards private equity. Commodities, sub-IG credit and listed equites are also more prominent due to the increased risk appetite of the growth cohort.

[11] Here we have used IFM's as the infrastructure asset class as it yields superior results. This is demonstrated in subsequent analysis in this paper.

These outcomes support the intuitive allocations that could be drawn from the dendrogram analysis in Graph 04. Primarily that IFM's UIP and IG fixed income offer differentiated returns characteristics that materially improve risk adjusted returns at the requisite level of risk appetite. Interestingly while private property offers a similar differentiation in the dendrogram in our modelled results it has a relatively stable weight across the risk spectrum – with only slight allocation variations across portfolios. This is largely driven by diversification benefits as risk/return characteristics were heavily impacted over the estimation window by the GFC and COVID.

3.3.1 Decomposing the result

Just how much Sharpe ratios are being improved by the respective private market allocations is of key interest to the respective investors. We quantify this in Graph 05 where it is clear, from the relative uplift of the investment frontiers, that Defensive investors benefit most from their private market allocation, followed by Balanced and finally Growth. Noting again that all investors have an equal maximum 30% allocation to private market assets.

From this we can assert that private market asset classes can also be useful in the context of pension fund investors by catering to members that are in different phases of their lifecycle. For example, in Australia most superannuants default into portfolios that are 'balanced' in the accumulation phase. But equally private market assets have a role to play in more defensive pension phase portfolios. One that historically has been assumed by fixed income products.

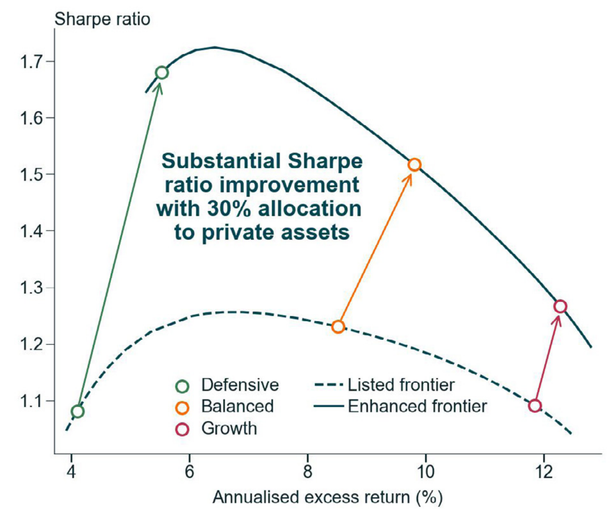
We can also identify just how the different private market asset classes impact the Sharpe ratio improvement of each investor type. This is achieved leveraging the result from Benhamou & Guez (2018) to decompose and quantify the improvements in the Sharpe ratio conferred by each private market asset across the risk spectrum. Graph 06 shows the result of this decomposition. We see that private credit and IFM's UIP have the greatest impact on the lower-risk portfolios which are preferred by defensive investors.

This overall result underscores why the prominent role for infrastructure and private credit was observed for the defensive and balanced investors earlier in Graph 04. We also observe that the overall Sharpe improvement from these asset classes decays as investors take more risk to achieve higher returns. As an investor moves up the risk curve, their portfolio Sharpe ratio improvement becomes increasingly reliant on private equity. This is an important result and was also initially observed in Graph 04.

Within the private market portfolio private equity becomes key for the higher risk/growth investor. Again, if we think about pension fund space this supports a greater risk appetite that characterises the early accumulation phase.

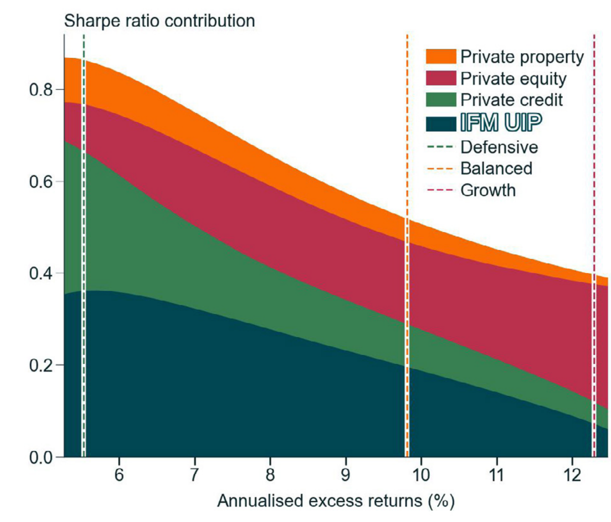
Of the other asset classes private property has a much smaller impact on the defensive investor portfolio which decays as higher returns are sought. We have noted in earlier and in previous work private property is heavily penalised by the crises that punctuate the estimate period.

GRAPH 05 **PRIVATE MARKET SHARPE RATIO IMPACT**



Source: IFM Investors, Bloomberg, Burgiss, MSCI

GRAPH 06 **SHARPE RATIO CONTRIBUTIONS**

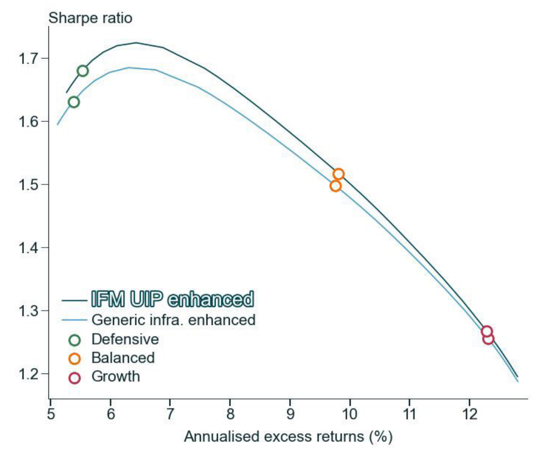


Source: IFM Investors, Bloomberg, Burgiss, MSCI

3.4 The IFM difference

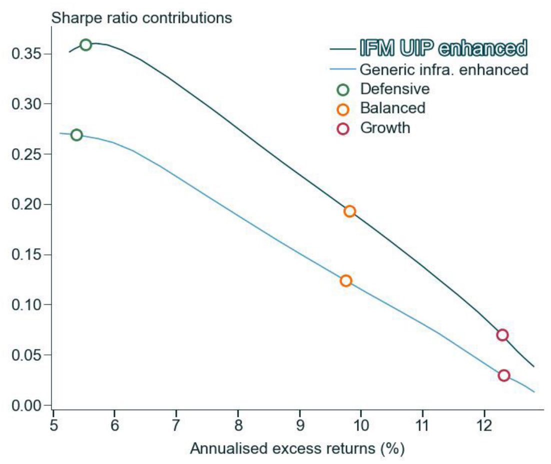
The importance of infrastructure in portfolios across the risk spectrum is an aspect of portfolio construction we continue to build strong insights into. While we assert that infrastructure generally has beneficial properties, portfolio construction within the asset class is also crucial. We highlighted this in detail in our 2024 paper. And we can again demonstrate this within the analysis in this paper. Up to this point we have used IFM's Infrastructure Portfolio (UIP) as the unlisted infrastructure asset class but the analysis was also run using the generic infrastructure benchmark returns series. We can compare outcomes in Graph 07. What we observe is that IFM's UIP risk return characteristics improves portfolio Sharpe ratios to a greater extent than a generic benchmark across all portfolio types. And further in Graph 07 can improve the Sharpe ratio of each portfolio outright more than the generic benchmark. In both cases IFM's UIP has a greater impact on the Defensive and Balanced portfolios than what it does on the Growth portfolio.

GRAPH 07 **IFM INFRA ENHANCED VS GENERIC INFRA ENHANCED SHARPE**



Source: IFM Investors, Bloomberg, Burgiss, MSCI

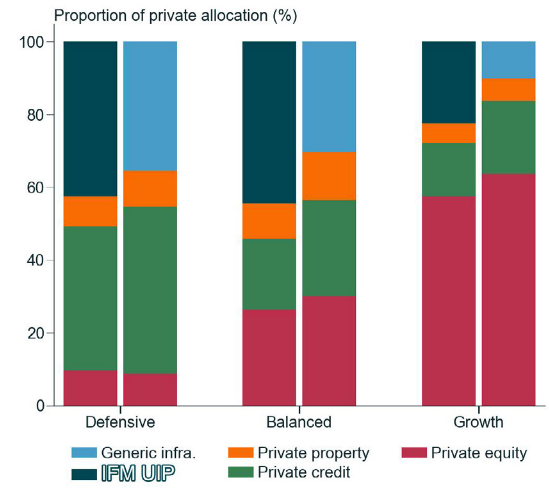
GRAPH 08 **IFM VS GENERIC INFRA SHARPE CONTRIBUTIONS**



Source: IFM Investors, Bloomberg, Burgiss, MSCI

The improved portfolio performance due to the inclusion of IFM's UIP instead of a generic benchmark is an important result for the asset allocation of the portfolio. We can observe this impact in Graph 09 comparing the asset allocations of the three portfolio styles. In each case the allocation to unlisted infrastructure is increased when IFM's UIP is the benchmark relative to when the generic benchmark is used. This is evidence of superior risk-return characteristics of IFM's UIP and the importance of portfolio construction within this asset class.

GRAPH 09 **IFM INFRA ENHANCED VS GENERIC INFRA ENHANCED WEIGHTS**



Source: IFM Investors, Bloomberg, Burgiss, MSCI

It is also useful for investors to get an idea of how stable the allocation of each asset class is in each portfolio. This is particularly true with private market assets where rebalancing can be less straight forward. We can explore this via the 'coefficient of variation' (CV) of each portfolio (see Table 01). The CV is defined as the standard deviation of the allocation to each asset class in each portfolio as a ratio of its mean allocation. This is a way to highlight the risk that the optimal allocation of a particular asset in any given simulation differs from the mean. In this way the CV gives some indication of how much active management or rebalancing an asset allocation may need in each portfolio risk environment.

The higher the CV of each asset class indicates that the portfolio's asset allocation weights are more volatile when seeking to fulfil the investor's portfolio objectives. This could lead to higher transaction costs and potential deviations from the intended risk-return profile. As can be observed in Table 01 asset class CVs that are low, implying allocations will be relatively stable to achieve investor objectives, align with the risk appetite of the investor type. For example, IG fixed income allocations are stable in a defensive portfolio and unstable in a growth portfolio. Similarly, private equity allocations are unstable in the Defensive context and more stable in the Growth portfolio.

IFM's UIP has the lowest CV of the private market assets indicating a relatively more stable allocation – particularly in the Defensive and Balanced investor case. It also has the lowest CV of any asset class outright for the Balanced investor. This is a notable outcome as we continue to assert that private market assets and IFM's UIP in particular are a key element of strategic asset allocation.

Table 01: Allocation coefficient of variation*

	Defensive	Balanced	Growth
IG fixed	1.4	7.6	23.1
Equity	9.2	8.9	5.9
IFM UIP	**4.2**	**7.3**	**14.6**
Private credit	7.2	15.3	20.3
Private property	31.9	37.9	45.7
Private equity	17.4	10.3	8.0

Source: IFM Investors, Bloomberg, Burgiss, MSCI. *Multiplied by 100

3.4.1 Infra head-to-head

Lastly, we can compare the portfolio performance metrics for each investor with the inclusion of IFM's UIP in their portfolio compared with the generic benchmark and then listed undiversified portfolio (with no private market assets in it).[12] The results from this show that IFM's UIP and generic infrastructure benchmark enhanced portfolios outperform, to a statistically significant degree, the listed asset portfolio. And similarly the IFM UIP outperforms the generic infrastructure benchmark on almost all metrics.

Below is a brief reminder of these metrics and how they are applied in this context in Table 1, for further technical detail see Appendix - Section 8.

Volatility: Measures the standard deviation of returns.

Sharpe Ratio: Higher values mean better risk/volatility-adjusted performance. This is where unlisted infrastructure asset returns characteristic impact most notably in a portfolio environment.

Max Drawdown (%): Largest percentage drop from peak to trough. Lower values suggest less severe potential losses; higher values indicate greater risk.

Sortino Ratio: Excess return divided by downside deviation. Higher ratios show better performance for downside risk; lower ones suggest poor handling of negative volatility.

Calmar Ratio: Annualized return over max drawdown. Higher ratios indicate better return relative to worst losses; lower ratios signal higher risk of significant drawdown.

Omega Ratio (0%): Probability of returns above 0% balanced against the probability of returns below 0%. Over 1 means favourable for positive returns; below 1, less so.

Omega Ratio (5%): Probability of returns above 5% balanced against the probability of returns below 5%. Above 1 suggests good potential for moderate returns; below indicates less likelihood.

Omega Ratio (10%): Probability of returns above 10% balanced against the probability of returns below 10%. Above 1 signals high potential for significant returns; below 1, less chance for high returns.

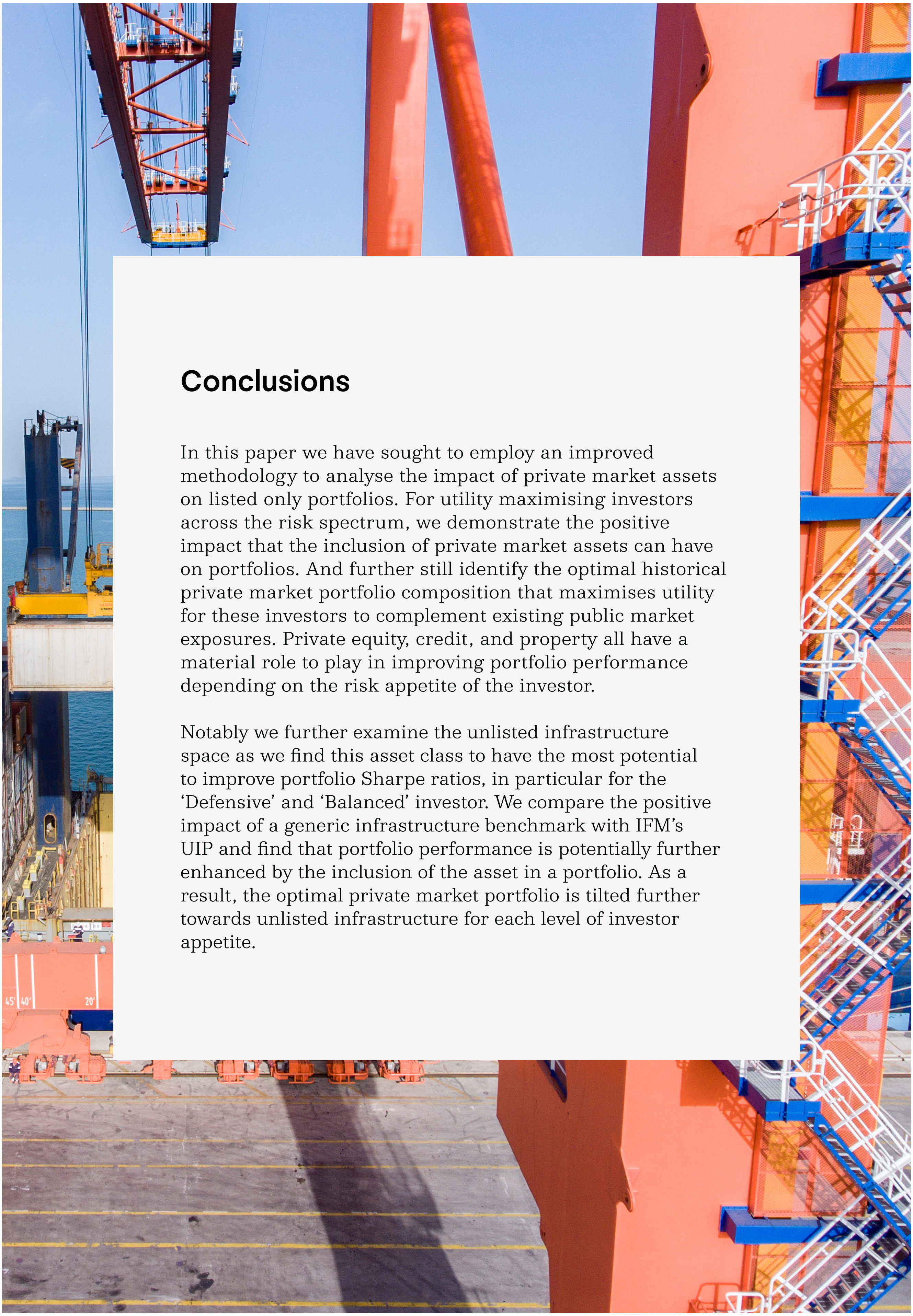
Table 02: Resampled back-tested portfolio performance metrics (5-year holding period)

	Defensive			Balanced			Growth		
Metric (median)	Listed	Generic enhanced	IFM enhanced	Listed	Generic enhanced	IFM enhanced	Listed	Generic enhanced	IFM enhanced
Return (%)	4.4	5.7	5.8	7.9	9.3	9.3	11.0	11.8	11.8
Volatility (%)	3.6	3.3	3.3	7.4	7.1	7.0	11.5	10.5	10.3
Sharpe ratio	0.54	0.77	0.80	0.50	0.61	0.62	0.44	0.52	0.52
Max drawdown (%)	-3.2	-2.8	-2.7	-7.3	-7.3	-6.9	-12.2	-12.1	-11.9
Sortino ratio	0.85	0.99	1.01	0.87	0.76	0.78	0.66	0.68	0.68
Calmar ratio	1.31	1.93	2.01	1.13	1.24	1.30	0.90	1.03	1.03
Omega ratio (0%)	4.73	7.65	7.67	3.89	5.08	5.26	3.88	4.68	4.78
Omega ratio (5%)	0.87	1.38	1.49	1.85	2.33	2.38	2.34	2.68	2.70
Omega ratio (10%)	0.15	0.16	0.15	0.82	0.99	1.00	1.40	1.51	1.50

Source: IFM Investors, Bloomberg, Burgiss, MSCI

Note: Green=Statistically significantly better than generic, orange=statistically significantly worse than generic, grey=no statistically significant difference between generic and IFM. Both generic enhanced and IFM enhanced are statistically and economically significantly better than the listed only portfolio in all cases.

[12] To achieve this we estimate performance statistics using 500 bootstrapped samples of 20 observations with replacement.



Conclusions

In this paper we have sought to employ an improved methodology to analyse the impact of private market assets on listed only portfolios. For utility maximising investors across the risk spectrum, we demonstrate the positive impact that the inclusion of private market assets can have on portfolios. And further still identify the optimal historical private market portfolio composition that maximises utility for these investors to complement existing public market exposures. Private equity, credit, and property all have a material role to play in improving portfolio performance depending on the risk appetite of the investor.

Notably we further examine the unlisted infrastructure space as we find this asset class to have the most potential to improve portfolio Sharpe ratios, in particular for the 'Defensive' and 'Balanced' investor. We compare the positive impact of a generic infrastructure benchmark with IFM's UIP and find that portfolio performance is potentially further enhanced by the inclusion of the asset in a portfolio. As a result, the optimal private market portfolio is tilted further towards unlisted infrastructure for each level of investor appetite.

Appendix

4. Technical box 1

Return unsmoothing: levelling the playing field
It is a common critique of private markets asset classes that their returns tend to exhibit smoothing, that is, the reduction in reported return volatility over time. This volatility reduction can stem from a number of factors including illiquidity, appraisal-based valuation methods, the averaging of external market inputs, the use of stale prices and managerial discretion, among others.

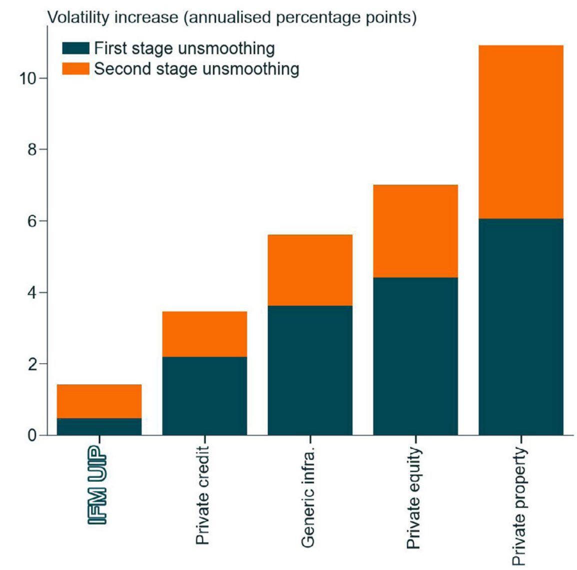
Returns smoothing can have a significant impact on investor asset allocation decisions by artificially inflating risk-adjusted return metrics like the Sharpe ratio. This is particularly important for quantitative portfolio construction approaches where risk is often proxied by return volatility. These approaches tend to exhibit a significant upward bias to private market assets and result in unrealistic asset allocation recommendations.

In order to address the issues of returns smoothing investors are increasingly seeking to unsmooth these returns using statistical methods. We have done this ourselves in our 2024 paper. However, in this paper we seek to push the methodology forward and apply a novel two-stage unsmoothing approach. This approach leverages techniques developed by Getmansky, Lo & Makarov (2004) (GLM) for the academic hedge fund literature and by Geltner (1993) for the academic private real estate literature.

We take this two-stage unsmoothing approach to underscore the credibility of our empirical analysis – we want to increase the likelihood that returns smoothing is not a primary driver of our result nor our conclusions. The GLM approach is a newer and more sophisticated unsmoothing technique than what we have employed previously. And although it does reduce return autocorrelations (see difference in phi coefficients in estimated phi table) – which is a key sign of returns smoothing – it doesn't completely address the autocorrelation issue. Therefore, we apply a second stage of unsmoothing as a conservative measure to remove any residual autocorrelations after that may remain after the first stage.

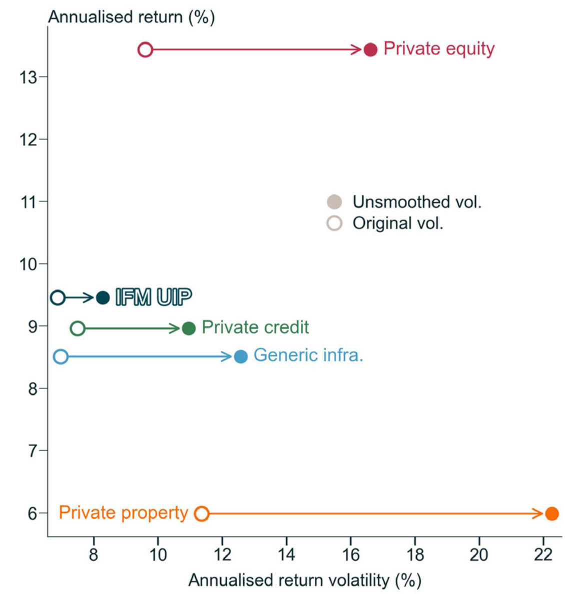
As can be observed in Graph 10, both stages tend to drive a material increase in volatility, underscoring the importance of the two-stage approach. Evident in Graph 11 is the amount of unsmoothing this methodology picks up for each asset class. A large volatility increase for an asset after the unsmoothing process suggests that the underlying valuations had previously underestimated the amount of risk (volatility of returns). This has implications for asset allocation given it implies materially lower Sharpe ratios in the unsmoothed context. It may also help in providing an estimate of the illiquidity premium. Indeed, Getmansky, Lo & Makarov (2004) note that the most likely explanation for serial correlation is illiquidity exposure, which suggests that the GLM smoothing profiles can serve as a rough proxy for the liquidity of an investment. The higher 'true' (unsmoothed) risk may justify a higher illiquidity premium, as investors demand more compensation for holding a riskier, less liquid asset.

GRAPH 10 **UNSMOOTHING IMPACTS**



Source: IFM Investors, Bloomberg, Burgiss, MSCI

GRAPH 11 **UNSMOOTHING RISK/RETURN CHART**



Source: IFM Investors, Bloomberg, Burgiss, MSCI

Interestingly, as observed in Graphs 9 and 10, IFM's UIP shows the least evidence of returns smoothing of the private market assets in our study. Meaning the reported volatility of IFM's UIP is closer to the 'true' return volatility than the other private market assets considered in this study. It is in sharp contrast to private equity and private property in particular and implies that illiquidity may be more material a factor in the returns of these asset classes to compensate investors. Investor demand, a limited investment space, a stable regulatory space and robust valuations methods may all be partial explanations for why the illiquidity premium is arguably lower in IFM's UIP than other asset classes including the generic infrastructure benchmark.

The technical

First, we run a stationarity test. Stationarity is necessary for the assumptions of the statistical models we apply. We find sufficient evidence to reject the null hypothesis of non-stationarity using the augmented Dickey-Fuller test (see technical appendix).

First stage – GLM:
The authors posit that observed returns are a weighted average of a series of lagged true economic returns. This is essentially a moving average – MA(k) – process and can be simplistically thought of as following the below:

$$R_t = \theta_0\, r_t + \theta_1\, r_{t-1} + \cdots + \theta_n\, r_{t-k}$$

Where R_t is the observed return at time t, r_t is the true economic return at time t and the Θ represent the weightings of past returns. Note that the authors also impose the following restrictions:

$$\theta_i \in [0,1]$$

$$1 = \theta_0 + \theta_1 + \cdots + \theta_k$$

True economic returns can then be estimated according to the below:

$$r_t = \frac{R_t - (\theta_1\, r_{t-1} + \theta_2\, r_{t-2} + \cdots + \theta_n\, r_{t-k})}{\theta_0}$$

It is also possible to calculate a 'smoothing index' which measures the overall degree of smoothing. This smoothing index is bound between zero and one where a lower value is indicative of more smoothing. This index, denoted by ξ, can be calculated according to:

$$\xi = \theta_0^2 + \theta_1^2 + \cdots + \theta_k^2$$

We fit an MA(k) model to each private market returns series where k represents the number of lags. The optimal number of lags is chosen based on the Bayesian information criterion (BIC). See table for the average estimated Θ's for each private market asset class.

Table 03: GLM unsmoothing coefficients

Asset	Θ_0	Θ_1	Θ_2	Θ_3	ξ
IFM UIP	0.90	0.07	-	-	0.82
Generic infra.	0.59	0.21	0.20	-	0.43
Private real estate	0.74	0.22	0.03	0.02	0.59
Private equity	0.63	0.20	0.17	-	0.46
Private real estate	0.54	0.24	0.22	-	0.40

Source: IFM Investors, Bloomberg, Burgiss, MSCI

Second stage – Geltner:
Author suggests that observed returns are a weighted average of current period economic returns and prior period observed returns according to:

$$R_t = (1-\phi)r_t + \phi R_{t-1}$$

This is essentially an autoregressive model of order one – AR(1) – and coefficients can be estimated accordingly. Returns can then be unsmoothed as in the below:

$$r_t = \frac{R_t - \phi R_{t-1}}{1-\phi}$$

Where R_t is the observed return at time t and ϕ is the estimated AR coefficient (see table for average estimated coefficients by asset class).

Table 04: Geltner unsmoothing coefficients

Asset	ϕ (post-GLM)	ϕ (pre-GLM)
IFM UIP	0.11	0.15
Generic infra.	0.17	0.32
Private real estate	0.12	0.34
Private equity	0.17	0.39
Private real estate	0.24	0.56

Source: IFM Investors, Bloomberg, Burgiss, MSCI

We take a conservative approach and apply the unsmoothing approach to all private market assets, regardless of the statistical significance of the estimated coefficients. This has the effect of upwardly biasing private markets return volatility to further ease concerns around private market assets understating true economic volatility.

5. Technical box 2

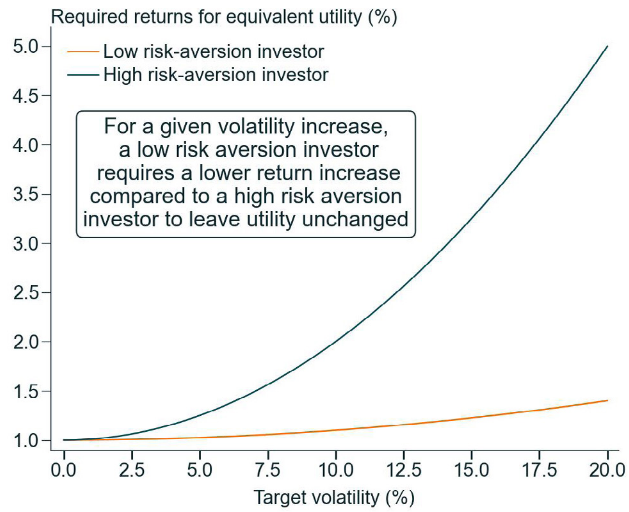
Utility maximisation in theory and in practice:
In this piece, we find optimal portfolios based on maximising investor utility, which is consistent with MPT. However, the way in which we maximise utility differs from that suggested by the theory and better reflects real-world portfolio allocation decisions.

To understand the motivation behind this we provide a high-level overview of the theory with a graphical example where we contrast the utility maximisation approach suggested by MPT with the more realistic approach that we employ. In this piece, we assume investors have a quadratic utility function of the form:

$$U = \mathrm{E}[r] - \frac{1}{2}\lambda\sigma^2$$

Where U is the utility to an investor of an investment, $\mathrm{E}[r]$ is the expected return of the investment, σ^2 is the return volatility of the investment, and λ is the investor's risk-aversion coefficient. The assumption of quadratic utility is commonplace in finance and economics – particularly in the context of mean-variance analysis and risk aversion – and can be thought of similarly to the Sharpe ratio: of two investments with equivalent expected returns, the lower volatility investment is preferable.

GRAPH 12 INDIFFERENCE CURVES



Source: IFM Investors

Unlike the Sharpe ratio, however, quadratic utility requires the specification of an investor's risk aversion. Graph 12 shows the indifference curves of two investors, one with a high risk-aversion and one with a low risk-aversion. The utility to each investor is held constant so, as risk increases, investors demand some increase in returns to keep utility constant. An investor with a higher risk-aversion will require a larger increase in expected returns for a given increase in volatility to leave utility unchanged.

To highlight how risk-aversion informs optimal portfolio selection in MPT, consider the following example (in Graph 13) with three assets, where each asset has a Sharpe ratio of one and a correlation of less than one with the other two assets. Diversification benefits mean that it is possible to construct a portfolio with a higher Sharpe ratio than each of the individual assets. The optimal portfolios of 'risky' assets are what defines the "efficient frontier", and the portfolio of risky assets with the highest Sharpe ratio is known as the "tangency portfolio".

It is important to distinguish between risky and risk-free assets in this context. Risky assets are any asset with non-zero return volatility, whereas the risk-free asset has zero return volatility. MPT states that there is only one optimal portfolio of risky assets, and this portfolio is the tangency portfolio. Allocating funds between the different risky assets to construct the optimal risky portfolio is known as the 'asset allocation' decision. The asset allocation decision is distinct from the 'capital allocation' decision. The capital allocation decision refers to what proportion of funds an investor will invest in the optimal risky portfolio versus the risk-free asset.

The implication of this is that investors with different risk preferences (risk aversions) should not adjust the weights of the assets in the risky portfolio, but should instead either 'lever up' or 'lever down' the tangency portfolio by borrowing or lending, respectively, at the risk-free rate. This defines the 'capital allocation line' – a line which starts at the risk-free rate and is tangent to the efficient frontier (hence the 'tangency' in the tangency portfolio name). This means that all investors should make the same asset allocation decisions, but will, depending on risk preferences, make different capital allocation decisions.

This is clearly an untenable assumption and is not how investment decisions are made in practice: defensive investors express their defensive preferences through a relatively higher asset allocation to safe assets like fixed income whereas growth focussed investors express their preferences through a relatively higher asset allocation to high returning assets like equities.

Part of the issue here lies in the fact that a truly risk-free asset as defined by MPT likely does not exist, nor can investors readily borrow or lend unlimited amounts of capital at the risk-free rate as is also required by MPT.

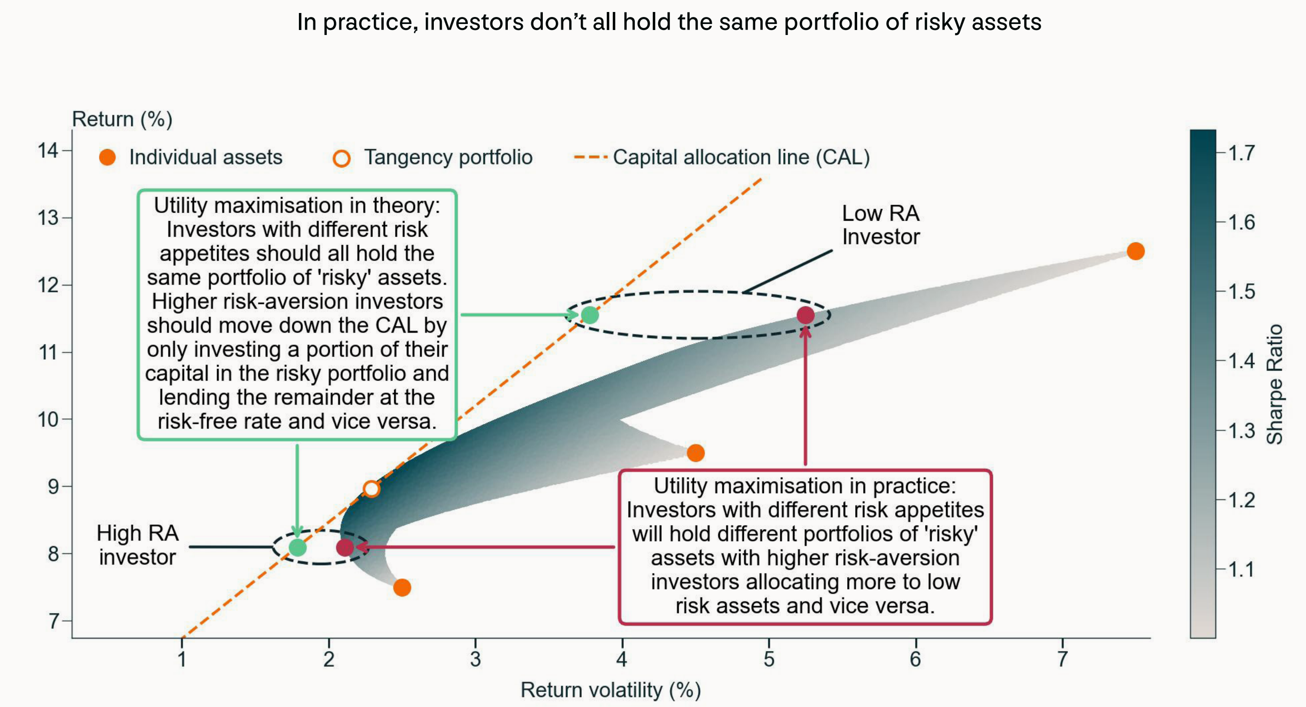
In order to more accurately reflect the actual investment process, we opt to focus on utility maximisation directly along the efficient frontier. This results in more realistic results where defensive investors maximise their utility by allocating more capital to relatively safer assets, and growth investors maximise their utility by allocating relatively more capital to higher return assets.

A key benefit of this approach is that it facilitates a more robust comparison of different portfolios both cross sectionally and over time. This is particularly important when resampling techniques are applied as it becomes challenging to define a coherent optimal investment strategy for each resampled data window.

For example, one would generally assume that a 'growth' strategy could be defined by specifying a target return level for the portfolio and then investing to achieve the desired return whilst minimising risk. But expected returns can be very volatile through economic cycles and it is highly unlikely that a single return target will be appropriate in all cases.

In a bull market it might be relatively easy to achieve an annualised return of say 15%, whereas in a bear market an annualised return of say 10% might be considered exceptionally good. Focussing on investor utility allows us to abstract from the target return issue and ensure that, regardless of the market cycle, different investor types will pursue a strategy that is consistent with their risk appetites. See risk/return footprint graph for listed portfolios as a stylised representation of how this approach satisfies the requirements.

GRAPH 13 **THEORETICAL VS PRACTICAL UTILITY MAXIMISATION**



Source: IFM Investors

6. Data appendix

Table 05: Asset proxies

Asset	Proxy
Risk-free rate	ICE BofA US 3-Month Treasury Bill Index
	ICE BofA Euro Treasury Bill Index
Investment grade (IG) fixed	Bloomberg Global Aggregate Corporate Total Return Index (Hedged, USD)
	Bloomberg Global Aggregate Government Total Return Index (Hedged, USD)
	Bloomberg Emerging Markets Investment Grade Total Return Index (Unhedged, USD)
	Bloomberg Global 1-3 Year Total Return Index (Hedged, USD)
	Bloomberg Global Aggregate 3-5 Year Total Return Index (Hedged, USD)
	Bloomberg Global Aggregate 5-7 Year Total Return Index (Hedged, USD)
	Bloomberg Global Aggregate 7-10 Year Total Return Index (Hedged, USD)
	Bloomberg Global Aggregate 10+ Year Total Return Index (Hedged, USD)
Sub-investment grade fixed income/Credit	Bloomberg US Corporate High Yield Total Return Index (Unhedged, USD)
	Bloomberg Pan-European High Yield Total Return Index (Hedged, USD)
	Bloomberg EM Hard Currency Aggregate Total Return Index (Hedged, USD)
	Bloomberg Global Aggregate Credit Total Return Index (Hedged, USD)
Listed equity	MSCI World Diversified Telecommunication Services Net Total Return Local index
	MSCI World Consumer Staples Net Total Return Local Index
	MSCI World Consumer Discretionary Net Total Return Local Index
	MSCI World Energy Net Total Return Local Index
	MSCI World Financials Net Total Return Local Index
	MSCI World Health Care Net Total Return Local Index
	MSCI World Industrials Net Total Return Local Index
	MSCI World Information Technology Net Total Return Local Index
	MSCI World Materials Net Total Return Local Index
	MSCI World Utilities Net Total Return Local Index
	MSCI World Infrastructure Net Total Return Local Index
	S&P Global REIT U.S. Dollar Net Total Return Index
Commodities	Bloomberg Precious Metals Subindex Total Return
	Bloomberg Industrial Metals Subindex Total Return
	Bloomberg Agriculture Subindex Total Return
	Bloomberg Petroleum Subindex Total Return
Private credit*	MSCI Global Private Credit Closed-End Fund Index
	MSCI US Private Credit Closed-End Fund Index
	MSCI APAC Private Credit Closed-End Fund Index
	MSCI Global ex-US Private Credit Closed-End Fund Index
	MSCI EMEA Private Credit Closed-End Fund Index
	Preqin Private Debt Index
	Preqin North America Private Debt Index
	Preqin Mezzanine Private Debt Index
	Preqin Distressed Debt Private Debt Index

6. Data appendix continued

Table 05: Asset proxies continued

Asset	Proxy
Private equity*	MSCI Global Private Equity ex-Venture Capital Closed-End Fund Index
	MSCI Global Buyout Closed-End Fund Index
	MSCI Global Expansion Capital Closed-End Fund Index
	MSCI US Private Equity ex-Venture Capital Closed-End Fund Index
	MSCI Global ex-US Private Equity ex-Venture Capital Closed-End Fund Index
	Preqin Private Equity excl. VC Index
	Preqin North America Private Equity excl. VC Index
	Preqin Europe Private Equity excl. VC Index
	Preqin Buyout Index
	Preqin Growth Index
Private real estate*	MSCI Global Private Real Estate Closed-End Fund Index
	MSCI Global ex-US Private Real Estate Closed-End Fund Index
	MSCI US Private Real Estate Closed-End Fund Index
	MSCI Developed APAC Private Real Estate Closed-End Fund Index
	MSCI Developed EMEA Private Real Estate Closed-End Fund Index
	Preqin Real Estate Index
	Preqin North America Real Estate Index
	Preqin Opportunistic Real Estate Index
	Preqin Value Added Real Estate Index
Generic infra.*	MSCI Global Private Infrastructure Closed-End Fund Index
	MSCI Global Quarterly Private Infrastructure Asset Index (backfilled with MSCI Australia Quarterly Private Infrastructure Fund Index prior to Q1 2008)
	Preqin Infrastructure Index (backfilled with average of MSCI Infrastructure indices prior to Q4 2007)

IFM UIP Refers to a proxy benchmark for global unlisted infrastructure that combines the net local currency returns of two core infrastructure portfolios managed by IFM

* MSCI Closed-End Fund Indices are constructed using the average of USD and EUR denominated indices to reduce currency impacts

7. Performance metrics

We provide a brief overview of the performance metrics used in Table 02. Note that for statistical significance we have used the Wilcoxon signed-rank test, a non-parametric version of the paired T-test.

Sharpe ratio: A mainstay of risk-adjusted performanc measurement. It is calculated by subtracting the risk-free rate from the expected return of a portfolio and dividing by the standard deviation of the portfolio's returns:

$$\text{Sharpe ratio} = \frac{R_p - R_f}{\sigma_p}$$

Where R_p is the return of the portfolio, R_f is the risk-free rate, and σ_p is the portfolio return standard deviation. One common critique of the Sharpe ratio is that it assumes returns are normally distributed and therefore doesn't take into account higher return moments such as skewness and kurtosis. The Sharpe ratio also treats all volatility equally and doesn't distinguish between upside and downside volatility.

Sortino ratio: Similar to the Sharpe ratio but uses downside deviation relative to a target return as the denominator and is useful for investors who are more concerned with downside risk.

$$\text{Sortino ratio} = \frac{R_p - R_f}{\sigma_d}$$

Where R_p and R_f are as in the Sharpe ratio but σ_d is the downside deviation relative to a given return target.

$$\sigma_d = \sqrt{\frac{1}{n}\sum_{i=1}^{n} \min(0, R_i - MAR)^2}$$

Where R_i is the return of the portfolio in period i and MAR is the minimum acceptable return. Note that we have specified MAR=0. The Sortino ratio is similar to the Sharpe ratio in that it assumes normally distributed returns and doesn't take higher return moments into account.

Maximum drawdown: An indicator of downside risk over a specific time period by quantifying the most significant drop in the value of a portfolio.

$$\text{MD} = \frac{V_{trough} - V_{peak}}{V_{peak}}$$

Where V_{trough} is the lowest portfolio value before a new high is established and V_{peak} is the peak value before the largest drop. One of the benefits of using maximum drawdown is that it is a non-parametric risk measure and requires no assumptions about returns distributions. It can prove misleading if used in isolation and is sensitive to outliers as it focusses only on the worst-case scenario.

Calmar ratio: A risk-adjusted performance measure using maximum drawdown as the measure of risk.

$$\text{Calmar ratio} = \frac{R_p}{MD}$$

Given that the Calmar ratio uses maximum drawdown as the risk measure, similar considerations impacting the usefulness of maximum drawdown apply here.

Omega ratio: Developed by Keating & Shadwick (2002), the Omega ratio is a more recent and sophisticated performance measure that takes into account the entire return distribution (including skewness and kurtosis). It can, therefore, provide a more detailed assessment of risk-return characteristics than measures using only mean and variance (e.g. Sharpe ratio, Sortino ratio).

$$\Omega(\theta) = \frac{\int_{\theta}^{\infty} [1 - F(r)]\, dr}{\int_{-\infty}^{\theta} F(r)\, dr}$$

Where θ is the threshold (or target) return and $F(r)$ is the return cumulative distribution function. The concept can perhaps be more simply expressed in discrete time according to the below:

$$\Omega(\theta) = \frac{\sum_{i=1}^{n} \max(R_i - \theta, 0)}{\sum_{i=1}^{n} \max(\theta - R_i, 0)}$$

Though the formulas may seem complicated, the Omega ratio essentially provides a way to understand the balance between the gains an investor is likely to achieve above a target return and the losses an investor is likely to achieve below that target return – a higher Omega ratio represents a better risk/reward trade-off.

The Omega ratio has the benefit of being non-parametric (i.e. requires no distributional assumptions) and is more flexible than the Sharpe ratio in that it allows investors to set different return thresholds and can therefore account for different risk preferences. However, the Omega ratio is a more complex metric and has more limited adoption in the industry despite its theoretical advantages.

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