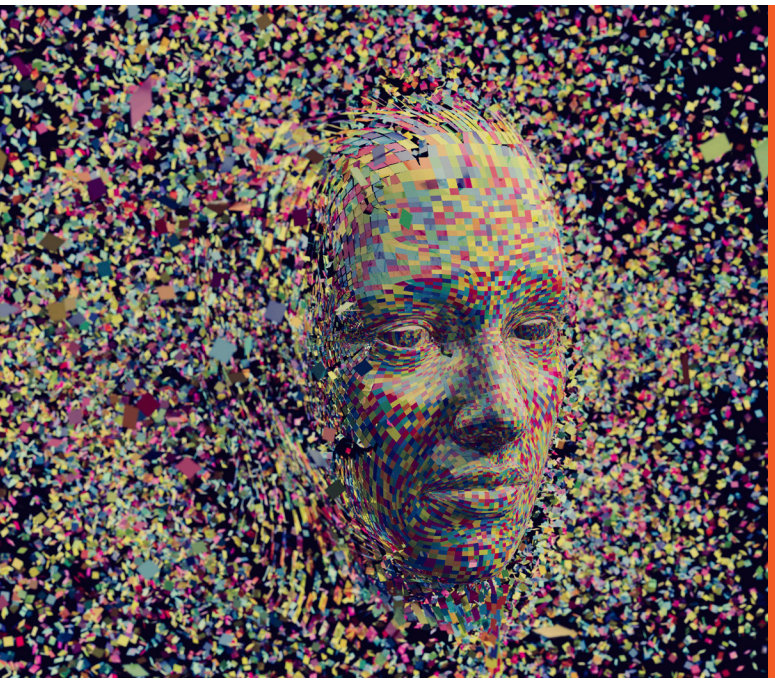

Alternative Investment Analyst Review

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Chosen pieces will be featured in future issues of AIAR, archived on **CAIA.org**, and promoted throughout the CAIA community.

Editor's Letter

Risk Parity and Volatility Targeting Strategies: Recent Performance

Alternative methods of asset allocations have gained wide acceptance in recent years. Fundamental indexing, risk parity, volatility targeting, smart betas, and alternative betas are just some examples of this new breed of asset allocation strategies. While these are not active strategies in the sense of taking positions based on active views of the expected performance of various asset classes or securities, they are not passive either. Rather they represent some form of deviation from the more common approach of using market cap weighted indices or allocations. In this brief note, I will discuss the main features of two strategies have been in the news during the last few months: risk parity and volatility targeting. By some estimates around $1 trillion are managed using these two asset allocation approaches. After briefly discussing each approach, I will examine some hypothetical and actual performance figures for these two strategies using S&P Risk Parity Index - 10% Target Volatility, J.P. Morgan Cross Asset Risk Parity Index, and AQR Risk Parity Fund-I.

Risk Parity Approach

The risk parity approach defines a well-diversified portfolio as one where all asset classes make the same contribution to the overall risk of the portfolio. That is, the goal is to create an equally weighted portfolio, where the weights refer to risk rather than dollar amounts invested in each asset.

Four important issues must be addressed in using the risk parity approach. First, we need a quantifiable measure of risk. The standard deviation of returns is typically used for this purpose. Second, we must be able to measure the contribution of each asset class to the risk of the portfolio. When standard deviation or volatility of return is used as a measure of risk, then measuring the contribution of each class to the total risk has a well-known formulation. Third, one does not need to forecast expected returns on asset classes to apply this method. Proponents of the risk parity approach consider this as one of its main advantages as models based on forecasted returns have poor track records. Finally, risk parity portfolios typically have low volatility and low returns. Therefore, unless investors are seeking to create a low vol/return strategy, the allocation must be levered up to generate returns in line with a 60/40 equity/bond portfolio. Critics of the risk parity approach consider leverage risk as one of its main shortcomings.

A simple but effective method of creating a risk parity like portfolio is to relate the weight of each asset class to the inverse of its volatility. That is,

$$\text{Weight of Asset } i = K \times \frac{1}{\text{Volatility of Asset } i}$$

The value of the constant is selected such that the weights would add up to one. In this approach, one assumes that various asset classes are equally correlated to each other.

As an illustration, consider the following estimates of volatility for equities, fixed income securities and commodities and their corresponding weights in a diversified portfolio

1/2017-10/2018	MSCI World Equity	Global Corporate Bonds	Medium Term Treasuries	Commodities
Annual Volatility	8.7%	4.1%	2.8%	14.4%
Weights	14.6%	31.1%	45.5%	8.8%

Source: Bloomberg

There has been some speculation in the press that recent spike in volatility and subsequent declines in equity prices have resulted from reallocation strategies of risk parity portfolios. To examine this issue, consider the above table, but let's use an estimate of volatility based on the last 30 trading days rather than the last 180 trading days, which is used in the above table.

9/14/18-10/25/18	MSCI World Equity	Global Corporate Bonds	Medium Term Treasuries	Commodities
Annual Volatility	14.1%	3.9%	2.9%	16.0%
Weights	9.7%	34.9%	46.9%	8.5%

We can see that the most recent increase in volatility would have required the above risk parity portfolio to reduce its allocation to equity by almost 5%. For each $100 billion managed using this strategy, the portfolio manager would have had to sell $5 billion in equities. The total amount of equity that had to be sold was not perhaps large enough to make a significant contribution to the market decline, but it certainly did not help either.

Volatility Targeting Approach

Volatility targeting is rather different from risk parity as it does not prescribe a specific approach to diversification. Instead, once a diversified portfolio is created, a volatility targeting approach suggests a method for increasing or decreasing the portfolio's exposure to market risk such that the return volatility is close to a prespecified target. Therefore, one could in principle combine a risk-parity portfolio with a volatility targeting strategy to create a risk-diversified portfolio whose return volatility is managed systematically.

To apply a volatility targeting approach, one must consider the following issues. First, we need a method for creating the diversified portfolio. This could be a diversified all-equity portfolio (e.g., MSCI World), a multi-asset portfolio (e.g.,50/30/20 equity/bond/alternative portfolio) or a multi-asset risk parity portfolio. Note that since the portfolio needs to be rebalanced frequently (e.g., weekly or monthly), the portfolio must consist of rather liquid assets. For instance, the allocation to alternative assets could consist of commodities and liquid alternatives. Second, we need to identify a volatility target (e.g., 10% annualized volatility). Third, we need to specify a method for estimating the volatility of the portfolio and the time horizon over which the volatility is estimated. Finally, we need to specify the maximum amount of leverage we are willing to employ. The market exposure (i.e., allocation to the risky diversified portfolio) is given below

$$E = \min\left(1+\text{Maximum Leverage}, \frac{\text{Target Volatility}}{\text{Realized Volatility of the Portfolio}}\right)$$

As an illustration, suppose the realized volatility of a 60/40 equity/bond portfolio is 5.5%, and the volatility target is 6%. If the maximum leverage allowed for this program is 10%, then market exposure would be:

$$E = \min\left(1 + 10\%+, \frac{6\%}{5.5\%}\right) = 1.091$$

This means we need 109.1% exposure to the market (the 60/40 portfolio) and therefore must use 9.1% leverage.

The impact of a spike in market volatility could be far more significant for a volatility targeting portfolio than a risk parity portfolio. For example, the volatility of the 60/40 portfolio increased to 8.4% during the past 30 days (9/14/2018-10/25/2018). As a result, the market exposure of the above example had to change to

$$E = \min\left(1 + 10\% + \frac{6\%}{8.4\%}\right) = 0.714$$

As a result, the allocation to equities had to be reduced by 22.6% while the allocation to bonds had to be reduced by 15%. Therefore, for each $100 billion managed under this strategy, the portfolio manager had to sell $22.6 billion in equities and $15 billion in bonds. These are not insignificant amounts. Of course, if a longer window is used to estimate these volatilities, the reaction could be smaller. On the other hand, the combined effects of risk parity and volatility targeting strategies could provide significant downward pressure on equity prices as both strategies will be selling equities as equity volatility spiked.

Hypothetical Performance

Here, I present hypothetical performance figures for the risk parity portfolio discussed earlier with 80% leverage and a 60/40 portfolio with a volatility target of 5.5%. The performance figures are presented below

	Annualized		
2017-2018	**Mean**	**Volatility**	**Info Ratio**
Risk Parity: No Leverage	3.20%	2.98%	1.076
Risk Parity: 50% Leverage	3.82%	4.47%	0.854
60/40 Portfolio: No Vol Target	6.95%	5.53%	1.257
60/40 Portfolioi: 4.5% Vol Target	6.03%	4.50%	1.340

Source: Bloomberg and Author's Calculations

The above figures highlight one particular problem with risk parity portfolios: if returns on the un-levered portfolio are low, then the use of leverage does not add much to the performance of the portfolio while the volatility increases. For example, in a flat yield curve environment, the cost of leverage, which is assumed to be 50bp above the yield on short-term Treasuries, will not be significantly different than the rate of return on the fixed income assets in the portfolio. Therefore, it will be up to the equity allocation to generate high enough return to justify the use of leverage. However, in a risk parity portfolio the allocation to equity is typically rather small.

On the other hand, the potential problem with volatility targeting strategy is that unless the permissible degree of leverage is high enough, the portfolio may end with a volatility that is below its target during a low volatility market environment. As a result, the portfolio may not take advantage of rising markets fully and suffer losses equal to the market during periods of declining prices.

Recent Performance

The following table presents performance figures for two indices and one fund covering January 2017 through October 25, 2018. These figures are calculated using the daily total return indices.

		Annualized	
2017-2018	**Mean**	**Volatility**	**Info Ratio**
S&P Risk Parity Index - 10%% Target Volatility	3.29%	4.79%	0..687
J.P. Morgan Cross Asset Risk Parity Index (Series A)	0.93%	4.38%	0.212
AQR Risk Parity Fund-I	5.25%	7.43%	0.706

Source: Bloomberg

The first index presented above is a combination of risk-parity and volatility targeting strategies. We can see that the realized volatility of this index is far below its target -- 10%. The reason is that during this period, markets were generally not very volatile, and the maximum leverage allowed by this index was not large enough to lever up the portfolio to generate 10% volatility. As a result, the portfolio's performance is rather low. The second index is a pure risk parity index with no volatility target. While the J.P. Morgan product has the same volatility as the S&P risk parity product, it has a substantially lower rate of return, which means not all risk-parity portfolios are created equal. It does matter what asset classes are selected to create the portfolio or how the risk allocations are implemented. The last example is the risk parity fund managed by AQR. It has a higher mean return than the other two but has also been more volatile. If we compare the information ratio of these three products, we can see that the AQR Fund has provided a higher mean return per unit of volatility over this period. However, all three of them have underperformed our hypothetical allocations, which do not include fees and transaction costs.

It is interesting to see how these three products have performed during October.

October 1- October 25	**Return**
S&P Risk Parity Index - 10%% Target Volatility	-2.5%
J.P. Morgan Cross Asset Risk Parity Index (Series A)	-4.2%
AQR Risk Parity Fund-I	-4.9%

Source: Bloomberg

We can see that all three have declined between 2.5% and 4.9%. By contrast, our 60/40 portfolio was down 5.1%, our no leverage risk parity portfolio was down 1.8%, and the MSCI World Index was down 8.1% during the same period. Risk parity and volatility targeting strategies have provided some downside protection compared to an all-equity portfolio, but the benefits have been negligible compared to the 60/40 portfolio.

There have been many academic and industry research papers around the relationship between risk and return. Risk parity strategies are based on the general finding that low volatility asset classes have provided a higher risk-adjusted return in the past. Therefore, a levered portfolio that has a relatively large allocation to low-risk assets should outperform an equally risky portfolio that uses market caps or similar weights. This argument rests on the assumption that not enough investors are able or willing to take advantage of this opportunity -- an assumption that may no longer be valid given the popularity of these strategies.

Volatility targeting strategies are meant to provide downside protection to a diversified multi-asset portfolio. Since volatility tends to spike when markets are performing poorly, this strategy could provide some downside protection as it de-levers as volatility increases. However, if the fund's market exposure (i.e., volatility) is adjusted too quickly, the fund may overreact to short-term spikes in volatility, and if the exposure is adjusted too slowly, the portfolio may not be protected against sharp declines (e.g., of the type we have seen during the month of October). Also, if the portfolio does not adjust quickly enough to a decline in market volatility, the portfolio may not participate in a market recovery that follows a spike in volatility. In short, there are no free lunches in financial markets, and no strategy will continue to match its back-tested performance if it is widely adopted by large investors.

Finally, as we saw in our hypothetical examples, during periods of increased volatility in equity markets, these two strategies could contribute to further declines in prices. The actual impact will be a function of the market size for these strategies as well as the methodology they use to estimate volatility of various asset classes.

Hossein Kazemi,

Editor

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The Essential Guide to Third-Party Valuations for Hedge Fund Investors

Erin Faccone, *CAIA*
NEPC

The Importance of Accurate Valuations for Hedge Funds

Investing in less-liquid or illiquid assets within a hedge fund structure is a complex issue. Hedge fund managers' challenges in this space are different from those of private equity managers. While private equity managers may face more complexity in valuing portfolios of truly private assets, they also benefit from closed-end investment structures where there are no Limited Partner (LP) transactions occurring in the interim that impact the portfolio before an asset sale and where fees are crystallized upon the sale of the asset. Hedge funds, on the other hand, must manage less liquid investments keeping in mind redemptions by investors that may occur frequently, often quarterly. Investors transact at net asset values, or NAVs, determined by valuations. LPs are typically permitted to subscribe monthly and redeem at the end of a quarter at the net asset value of the investment vehicle.

In addition, accurate asset valuations are critical for hedge fund managers as their fees—management and incentive payments—are determined monthly or quarterly based on unrealized market values; investor redemptions crystallize these fees regardless of later underlying asset sales.

A Robust Valuation Framework

At NEPC, we have observed a multi-layered approach to valuing illiquid assets held through investment vehicles at hedge funds.

Starting from the top, every fund manager must have a written valuation policy in place that is used to price the portfolio. We have the following recommendations to ensure a robust valuation policy:

(a) Thorough: The policy should be detailed and specific to the assets in which the fund invests.
(b) Compliant: The firm's compliance department and the fund's board of directors should sign off on the valuation policy.
(c) Pricing sources: The policy should specify primary, secondary and tertiary (if necessary) pricing sources for each asset type and outline the process for resolving price discrepancies.
(d) Valuation committee: A formally organized valuation committee should meet to review and approve the completed valuation package monthly before striking the NAV.

Additionally, best industry practices dictate that portfolio managers should not be voting members of the valuation committee, as their compensation is frequently tied to portfolio performance and their ability to vote would create a conflict of interest.

In an emerging trend, managers are actively engaging third-party valuation specialists for guidance on pricing less-liquid or illiquid assets. To the extent third-party service providers are utilized in the valuation process, the valuation policy should indicate the circumstances under which these providers are used, which providers are used (and for which asset types), and the process by which their reports are provided to the manager and recorded in the minutes of the valuation committee meetings.

As the reliance on third-party valuation specialists increases, it is vital for investors to understand the role they play. Presently, convention calls for the use of external service providers for their independent and unbiased fair-value estimate on illiquid or non-trading assets. Where, in the past, managers might price an asset to internal models or solitary broker quotes, investors, regulators and auditors may prefer an objective assessment from a third party.

The increasing clamor for external valuation experts is at least partially due to guidance from the American Institute of Certified Public Accountants (AICPA), which allows limited partners to use the stated NAV as their fair value estimate for private fund holdings, but only after verifying that the fund is providing fair value-based NAVs to the LPs.

Investors may accept private fund NAV as fair value, if the production of that fund's NAV is consistent with ASC 820 fair value guidelines. This creates a burden for LPs to verify valuation methodology and consistency with fair value guidance. To the extent a fund is investing in less liquid or private investments, the call for external valuation providers brings additional assurance to the fair value measurement.

To be sure, the hedge fund manager still has ultimate responsibility for the fair value estimate even if a third party is involved in the valuation process. It is also possible that an investment manager overrides a valuation from an independent provider in favor of pricing derived through internal models. This practice effectively defeats the purpose of hiring a third-party provider and is often not clearly reflected in price-assurance reports to investors. To this end, investors must pay close attention to the valuation procedures and internal controls in place to ensure the process is well-defined and monitored. An exaggerated valuation can inflate performance and fees while an overly cautious estimate can distort redemptions to the disadvantage of investors.

Types of Services from Third-Party Valuation Providers

Third-party valuation providers typically offer these three services to hedge fund managers:

i. Negative assurance: This is the least detailed approach, under which the hedge fund manager provides a self-created valuation report to the third-party valuation provider. The outsourced valuation specialist reviews the manager's pricing methodology to determine the approach used is not unreasonable. This process covers only the pricing model; it does not address the validity of the methodology for the asset in question or the particular inputs used in the valuation model.
ii. Positive assurance: This service takes the negative-assurance process a step further with the independent valuation expert reviewing the inputs and methodology provided by the hedge fund manager to opine that they are reasonable and in line with industry standards.
iii. Full valuation: This is the most detailed service and, as a result, the costliest. Therefore, it is also the least utilized. Here, the third-party valuation provider carries out a detailed analysis on the relevant inputs, discount rates and pricing methodologies. The end result consists of providing the manager with an acceptable valuation range or spot value for the asset.

The Drawbacks to Third-Party Valuations

(i) False sense of security: All third-party valuation providers are not created equal. Investors and hedge fund managers alike should guard against complacency while using the services of an outsourced firm. While many are capable, individual providers typically specialize in particular asset classes and, therefore, it is critical to match the right valuation specialist to the asset type.

(ii) Multiple valuations for same asset: A firm may value the same investment differently for multiple funds. A position could be marked differently in two funds for reasons such as a difference in the size of the position, different model inputs, or different pricing methodology. However, we would expect there to be some reasonable threshold for multiple prices of the same security across a number of funds. For instance, one fund holding a security at 20 cents on the dollar while another valuing it at 90 wouldn't

be explainable by those factors. NEPC's Operational Due Diligence team reached out to a number of valuation specialists to better understand these challenges to their business. For instance, the service providers we spoke to had internal mechanisms to catch different prices ascribed to the same asset across multiple clients, but there was no protocol to ensure consistency. This is largely because the basis for "reasonableness" for assurance providers allows for disparate clients to use different inputs or methodologies for the same asset, leading to different valuations, while still satisfying the "reasonable" clause.

(iii) Lack of communication: While independent valuation providers have fiduciary responsibilities, they have no direct contact with investors. They can be fired at will by the fund management company without notifying investors. They can be terminated over significant disagreements around asset pricing and in cases where the two parties could not resolve a discrepancy in the external and internal valuations. In fact, NEPC has encountered managers touting the use of third-party valuation agents only to override non-assurances or maintain modeled pricing.

(iv) Limited accountability: Independent third-party valuation providers are often indemnified by the funds for their duties. Indemnification protects them from legal action by investors unless investors can prove gross negligence. This increases the moral hazard of the relationship where the third-party provider should be accepting the fiduciary responsibility on behalf of the investors, but is hired and reports to the manager.

A Roadmap for Investors

To navigate the potential pitfalls mentioned above, we encourage investors to take a more active role in seeking greater transparency around how hedge funds value their illiquid holdings. Investors should question their investment manager to gain comfort around valuation methodologies and compliance. To this end, the following check list should be included by clients during their due diligence process:

- We recommend a careful reading of the valuation policy. Is it specific to the types of investments held by the fund? Has it changed in the last year? Valuation policies are not consistent between managers so it is important to read each one individually.
- It is vital to understand the third-party vendors being used and the asset types covered by them. Does the named service provider have expertise in the asset class it is engaged to value?
- What level of service is being provided? What happens if the outsourced provider does not assure the manager's pricing, or provides a value range that does not include the manager's price?
- Has the independent valuation specialist ever been asked to not issue a report on a security it was tasked with pricing?
- How are price exceptions recorded and approved? Does the board receive reports of pricing exceptions?
- Has the third party interacted with regulators regarding its valuation opinions, and did it withstand regulatory scrutiny?
- Are Level 3 securities, that is, highly illiquid assets, priced using the same methodology at each valuation date? Are changes to the process documented, along with the reasons for the changes? Under what circumstances is the methodology or inputs altered?
- In the instance where funds are receiving a range of values from a third-party vendor, what is the process for deciding the point value within that range used to strike the fund's NAV? Is there ever a case where the point value used for the NAV is outside the provided range?

Conclusion: Trust but Verify

We believe using third-party valuation services is a best practice for hedge funds with any illiquid exposure and strongly encourage this as part of operational reviews. To the extent clients are individually visiting investment managers, this paper can serve as a starting point for discussing valuation. Our mantra, trust but verify, is of the utmost importance in this area of due diligence; even the most seemingly detailed valuation policies are subject to discretion. We encourage our clients to vigorously examine and question their fund managers so their investments do not fall prey to mispricing.

Disclaimers and Disclosures

- *Past performance is no guarantee of future results.*
- *All investments carry some level of risk. Diversification and other asset allocation techniques do not ensure profit or protect against losses.*
- *The information in this report has been obtained from sources NEPC believes to be reliable. While NEPC has exercised reasonable professional care in preparing this report, we cannot guarantee the accuracy of all source information contained within.*
- *The opinions presented herein represent the good faith views of NEPC as of the date of this report and are subject to change at any time.*

Author Bio

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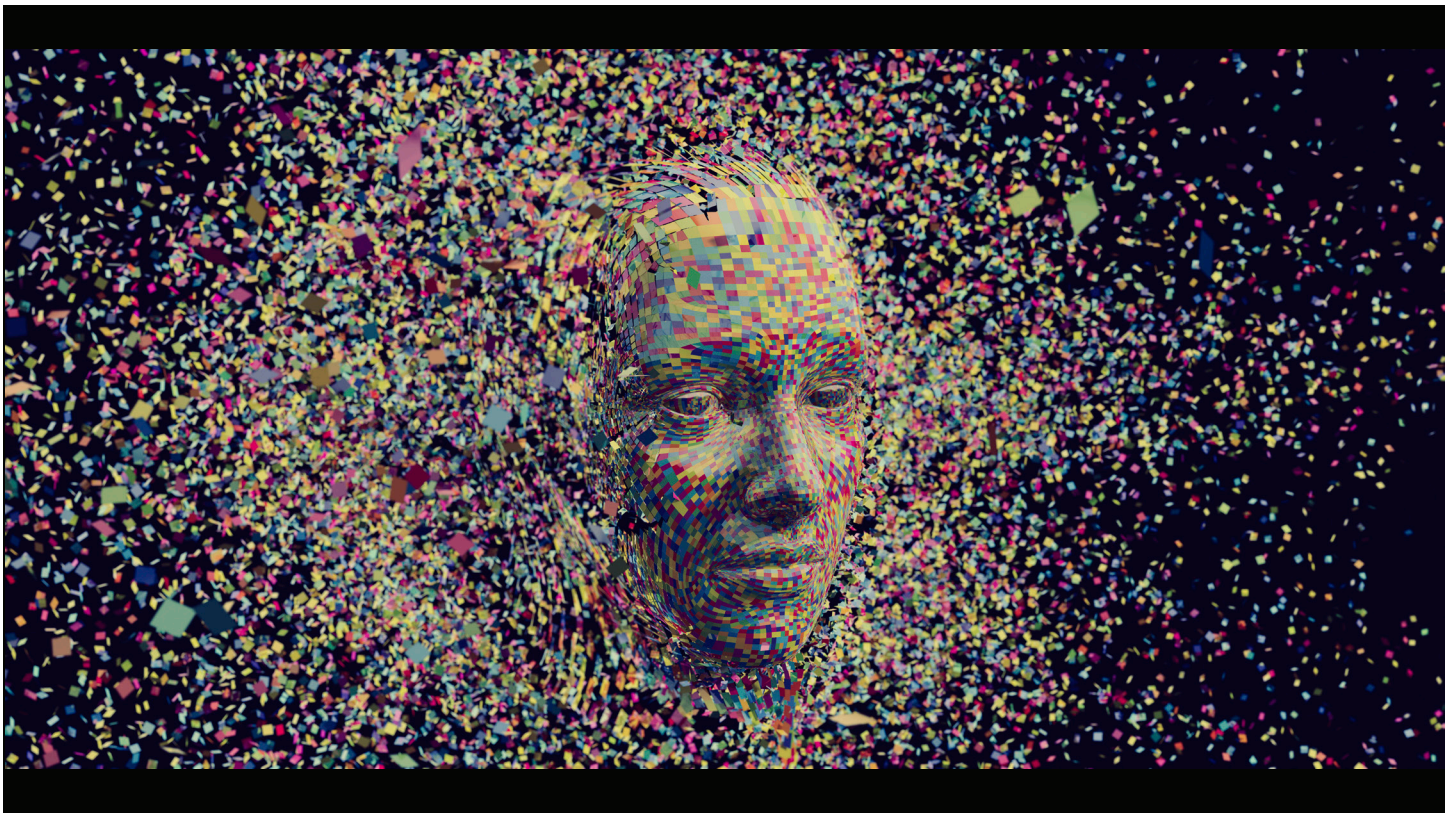
Erin joined NEPC in January 2011 and is currently the Director of Research Operations. Previously, she was a Senior Consultant on the Operational Due Diligence team at NEPC, conducting in-depth analysis of hedge funds including all aspects of a fund's infrastructure, trading and reconciliation, risk management, compliance, and management.

Prior to NEPC she was a Senior Research & Portfolio Analyst with KStone Partners, a startup hedge fund-of-funds manager. In this capacity, she was responsible for all aspects of fund-of-hedge-fund portfolio management including manager sourcing, research, due diligence, presentation to the Investment Committee and liquidity management. She maintained close contact with a portfolio of over thirty invested funds, monitoring portfolio investments, P&L, risks and operational issues.

Erin graduated Magna Cum Laude from Loyola College in Maryland with a B.B.A. degree concentrated in Finance and a minor in Political Science. She is a member of 100 Women in Hedge Funds. Erin holds the Chartered Alternative Investment Analyst (CAIA) and the Chartered Financial Analyst designations.



Artificial Intelligence - Chances and Challenges in Quantitative Asset Management

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Artificial intelligence has recently experienced a remarkable increase in attention, following staggering achievements in applications such as image, text and speech recognition, self-driving cars or chess and Go tournaments. It is therefore not surprising that also the financial industry is ever more heavily trying to improve investment decisions by incorporating self-learning algorithms into the investment process. For that matter, the application of quantitative tools and algorithms in order to define systematic trading strategies has already a strong history in the hedge fund industry. Against this backdrop, quantitative hedge funds may provide a fertile soil for the application of new machine learning techniques. But do all sectors of the asset management industry exhibit characteristics that can be exploited by artificial intelligence tools to uncover new patterns? What could be the especially relevant fields? Are there limits beyond which additional computing power and greater data availability have only marginal benefits? This research note provides some initial answers. It shows that the adaptivity and self-learning capability of machine learning tools could add value along the entire value chain of an asset manager. However, the inherently flexible nature of machine learning methods is also the biggest challenge. These methods must be applied thoughtfully and in the right context. We start with a general overview of machine learning, then elaborate on specific applications in quantitative asset management, highlighting the limitations, challenges and possible remedies before reaching our conclusions.

From Machine Learning in General ...

Machine learning refers to extracting knowledge from data by iden- tifying correlated relationships without receiving prior information about what causal dependencies to look for. It combines elements

from both statistics and computer science and has been in existence for many years. As early as 1956, John McCarthy at a conference on the campus of Dartmouth College coined artificial intelligence as "the science and engineering of making intelligent machines". However, it is mostly due to recent significant advancements in computing power and data availability that the application of artificial intelligence algorithms has become relevant in everyday life.

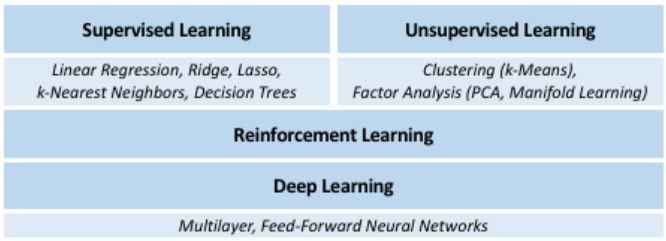

Exhibit 1: Artificial Intelligence and Exemplary Methods
Source: Aquila Capital Concepts GmbH

Most machine learning methods have been developed outside of finance and built on well-known statistical models such as linear regression or clustering techniques. Still, machine learning allows for much more flexibility, for example, by allowing for nonlinearities and feedback effects, or by completely refraining from any prior knowledge about the problem under scrutiny. It can be applied to different kinds of problems, such as classification or regression analysis. Classification algorithms group observations into a finite number of categories, whereas regression analysis estimates outcomes to problems that have an infinite number of solutions. While machine learning is a very broad field, it can be classified into three main areas.

The currently most successful field is supervised learning, where algorithms learn based on training data that reveal known relationships. Examples of supervised learning include tasks such as the detection of fraud in credit card transactions or the creditworthiness of debtors. The simplest form of a supervised learning algorithm is linear regression, which makes a prediction using a linear function of the input features, by learning the relationship based on minimizing the mean squared error between predicted and true regression outputs. There is a general trade-off between optimizing the fit of a model on the in-sample training and the true out-of-sample prediction period. Given that all models tend to fit the training data better the more input variables are used, it may be reasonable to penalize additional model complexity in order to maintain sufficient generalization power for the prediction task. Methods such as ridge or lasso regression help in automatically detecting the most relevant input variables by regularizing model complexity to avoid overfitting. While the ridge regression relies on minimizing the importance of less relevant factors, the lasso regression completely discards input parameters whose importance lies below a certain threshold. All three methods are, by nature, linear, but may account for non-linear relationships based on an appropriate manipulation of the input variables, for example, by interacting themselves or by building polynomials on the original data. A simple machine learning method that is not constrained to linear relations is the k-Nearest Neighbors algorithm. This model looks for the k historical data points that come closest to the current situation and predicts future values based on these historical "neighbors".

There exist more complex non-linear supervised learning algorithms such as decision trees or random forests, which in essence learn by a sequence of if/else rules that get to the true answer the fastest. However, they are not able to extrapolate or make forecasts outside of the range of the training data.

Contrary to the methods described in the section above, unsupervised learning algorithms only receive input data to learn from, but no information about the output data or relationships. These algorithms therefore detect patterns in the data by identifying clusters of observations that depend on similar characteristics. Machine learning can, for example, be used to identify the main topics in the news flow for a given stock, or to look for a liquid security that mimics the characteristics of an illiquid asset. At the core of unsupervised learning algorithms is the idea of reducing dimensionality by clustering the data or by transforming it into simpler factor rep- resentations. Clustering methods partition the input data into subsets that exhibit common characteristics, such that the data points within a cluster share some notion of similarity that decisively discriminates them from the data points in other clusters. Factor analysis, on the other hand, relies on transforming the original data into the most relevant drivers or the most appropriate representation. The principal component analysis, for example, first finds the direction of maximum dispersion in the data, assuming that this dispersion contains most of the information about the first factor driving the data. It then finds the direction in the data that again features the highest dispersion but, at the same time, is uncorrelated to the previously identified factor.

Combining methods of supervised and unsupervised learning results in so-called reinforcement learning, where an algorithm first detects patterns on its own, and then receives feedback from an exogenous source to validate or further guide the learning process. A reward feedback is required for the algorithm to learn a certain behavior. For instance, self-driving cars can learn collision avoidance by learning from the negative feedback received from crashing into obstacles, or computers can teach themselves the rules of games such as chess or Go. Hence, the reward feedback need not necessarily be provided by a human being.

Artificial intelligence literature also frequently refers to deep learning or neural network algorithms. This kind of method, in a certain sense, mimics the function of the human brain by feeding information through different layers and nodes. It can be applied to all of the three areas outlined above. The simplest form is called multilayer perceptron and can be seen as a generalization of linear models that perform multiple regression steps. Each node of a certain layer of the network computes a weighted sum of the input information received from the nodes of the foregoing layer and applies a nonlinear function to the result. This process is repeated multiple times until the final output value is calculated. Given that in this setup the information passes through each node only once, such neural networks are also designated feed-forward. There exist more advanced networks to deal with the challenges of simple networks which, for example, also propagate information backwards through the network. Given that even a sketchy synopsis of this field would exceed the scope of this research note, we refer the interested reader to corresponding abundant literature.

Investment Process	Possible Machine Learning Applications	Exemplary Methods
Investment Universe	– Identifying uncorrelated assets – Data mapping allowing for interpretation – Proxy asses with more liquid instruments	– Dendrogram – PCA, manifold learning – k-means
Signal Creation	– Create nonlinear forecast – Forecast based on predefined factors – Forecast without prior factor knowledge – Forecast based on new data sources	– Linear, lasso, ridge regression – k-nearest neighbors – Bag-of-words, term frequency-inverse document frequency
Portfolio Construction	– Improve estimate of input parameters – Dynamically maximize target value – Scenario and stress testing	– PCA – Lasso, ridge regression – k-means
Trading	– Pricing based on sparse data – Non-linear relations in transaction costs	– k-means – Lasso, ridge regression

Exhibit 2: Artificial Intelligence Applications in Quantitative Finance
Source: Aquila Capital Concepts GmbH

Each sector within the financial industry uses artificial intelligence methods differently and according to their specific needs. Insurance companies, for example, use it among other applications to detect fraud in damage events. Banks count on it to assess credit quality or employ robotic process automation for middle and back office tasks. In wealth management, applications are only just emerging, with a current focus on automatically ensuring regulatory requirements, client segmentation, chatbots to deal with repetitive client requests or portfolio management based on robo advisors. But in what areas of asset management can artificial intelligence provide added value? What problems faced by investment managers may not be solved by such tools?

When we think about modelling the investment process – and about using machine learning algorithms to improve decision making – we can subdivide the value chain into different steps. This allows for a systematic application of models that are appropriate for a specific task. We will provide details of the various steps in the next section, but start with an overview in order to facilitate the synopsis.

The first step consists of the defining of the investment universe, and of collecting and cleaning the corresponding data sets. Next, the alpha engine or signal engine preprocesses the data in a proper way, calculates the signals for the various markets under scrutiny based on the models used, and maps these signals into the portfolio context. Then, the portfolio construction engine or risk management engine builds the theoretical model portfolio based on a suitable algorithm, such as mean-variance or maximum diversification, taking regulatory and investor specific limits into account. Finally, the trading engine translates changes in the model portfolio positions into effective trades, while routing orders between different market venues, minimizing transaction costs and avoiding slippage and market impact. In contrast to our structured approach with clearly defined tasks for the application of artificial intelligence, it would also be possible to more generally ask such an algorithm to completely choose an investment rationale on its own. However, we cover that question in the section that discusses the challenges and limitations of machine learning models.

What then, in more detail, do these general descriptions adhere to? Let us start with the investment universe, where machine learning tools may assist in identifying uncorrelated assets that provide true diversification benefits; or in the mapping of data into new representations that allow for other interpretations, such as the detection of style drifts in hedge fund strategies or, for instance, factor exposures such as momentum or value. An appropriate tool for the first task would, for example, be a dendrogram analysis (see exhibit 3: Clustering the Investment Universe with Dendrograms); the second goal could be achieved by relying on a principal component or manifold learning analysis. In a similar manner, artificial intelligence methods can be used to proxy valuation or even the actual investment of assets for which there is only sparse historical market data or that are not eligible due to liquidity issues. In the latter case this can be achieved by substituting more liquid instruments that appropriately mimic the characteristics of the desired assets. A useful variant to achieve that task would be the k-Nearest Neighbor model.
The aim of the alpha or signal engine in our context is to generate forecasts about the direction and magnitude of future asset price movements or about the riskiness of assets, and to translate that information into a meaningful signal for the portfolio construction engine. Potential applications of machine learning methods in this field can be classified into three main blocks. First, an artificial intel- ligence algorithm may be helpful in creating a nonlinear forecast based on a single time-series (see exhibit 4: Analyzing the Behavior of the VIX Index with KNN). Second, machine learning methods may derive forecast value out of a predefined pool of relevant factors.

An elucidatory example would be the dynamic, selective weightings of a given set of moving averages over various time windows, depending on some historical pattern or exogenous factors. More involved is a third application, consisting of letting

Case Study 1: Clustering the Investment Universe with Dendrograms

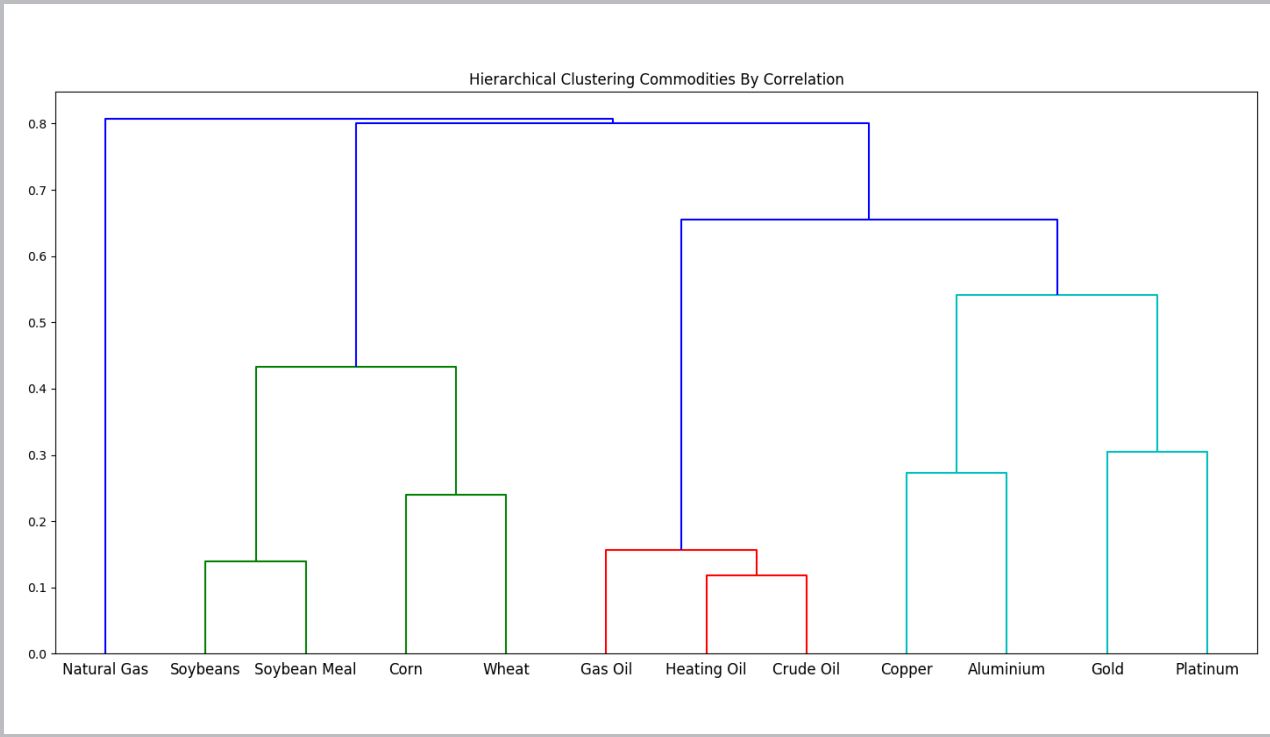

Exhibit 3: Clustering the Investment Universe with Dendrograms
Source: Aquila Capital Concepts GmbH

Dendorgrams belong to methods of hierarchial clustering. The algorithm iteratively clusters first individual data points and then sub-clusters into a hierarchial order, depending on the correlation structure. We use a dendrogram to structure a set of individual commodity markets into more meaningful clusters. Ideally, it comes up with well-known sectors, perhaps energy, precious metals and industrial metals. At the bottom of the visual representation in Exhibit 3 are the single data points that are joined in first clusters. For example, the model groups copper and aluminium into a mutual cluster of industrial metals, or gold and platinum into a cluster of precious metals. These two clusters are then joined to form a more general cluster of metals. Similarly, heating oil and crude oil are merged before being clustered together with gas oil to form an energy complex. The energy and metals clusters are then combined to form a cluster of commodities that are highly dependent on changes in the business cycle. The soft commodities - soybeans, soybean meal, corn and wheat - are structured into a separate node that only consists of agricultural products. Interestingly, natural gas forms and individual cluster, most likely because of seasonality factors that separate it from other energy commodities.

Case Study 2: Analyzing the Behavior of the VIX Index with KNN

The VIX Index measures market expectations for the volatility of the S&P 500 Index over the coming month, based on index option prices. Given that volatility can neither become negative nor grow boundlessly, theory suggests a mean reverting behavior. Additionally, the distribution of changes in volatility is commonly skewed, mimicking the fact that spikes in volatility often occur very quickly, while a reduction in volatility normally takes more time and tracks a bumpier road.

Exhibit 4: Analyzing the Behavior of the VIX Index with KNN
Source: Aquila Capital Concepts GmbH

Given that backdrop, we analyze the predictive power of two moving averages of past index movements for the future direction of the VIX Index based on a k-nearest neighbor classification algorithm. Exhibit 4 plots the values of the short moving average on the x-axis and the values of the long moving average on the y-axis. Conditional on the value of these two moving averages, the blue points reprpesent moments in time where the future VIX Index movement was negative, and the green points indicate future positive directional changes. while it is difficult to extract a meaningful interpretation from this scatter plot, a k-nearest neighbor analysis reveals further information. Based on this estimator, Exhibit 4 shows the decision boundaries for the two states of future directional movements in separate colors. The area colored in blue represents states where the two moving averages indicate falling VIX levels., whereas the red area stands for scenarios in which the two moving averages predict a rising VIX. Clearly, positive values for the moving averages are related to negative future VIX price movements, confirming a mean reverting behavior after an increase in volatility levels. The picture for negative moving average values is more ambiguous, overall upholding the thesis of mean reversion, but also showing some signs of momentum. That makes intuitive sense, as volatility tends to trend lower after a sudden spike.

the model select relevant input signals on its own or access new data sources in order to extract additional information, for example, by clustering social media posts or news announcements in order to construct alternative sentiment indicators based on a bag-of-words or term frequency-inverse document frequency (TFIDF) algorithm.

Based on these forecasts, the portfolio construction or risk manage- ment engine calculates target positions, taking regulatory and internal restrictions into account. In this step, artificial intelligence methods may be helpful in improving estimates for input variables such as expected returns or the variance-covariance matrix for large portfolios in the context of limited historical data. This could, for example, be achieved by reducing the dimensionality of the dataset based on clustering algorithms such as a principal component analysis. Instead of optimizing the portfolio with respect to a predefined objective function and specific constraints, machine learning tools may also be asked to tweak the portfolio in a more general way. For instance, by dynamically weighting the portfolio components such that risk-adjusted returns as measured by Sharpe ratios or the ratio of average returns to maximum drawdown are maximized. Finally, enhanced scenario analysis tools may improve model validation and stress testing applications.

The trading engine finally translates target positions into effective market orders. This step is especially relevant for large asset managers, as an estimated two thirds of gains on trades are lost due to market impact costs when trading into and out of large position blocks. In this area, artificial intelligence may serve to obtain additional information from sparse historical data or help identify nonlinear relationships in order flow to calibrate trading algorithms based on both nonlinear regression tools and clustering algorithms.

In the previous section, we highlighted various steps along the value chain of a well-structured investment process that, in our view, are suitable for further enhancement by machine learning applications. Does that mean we are unconditional believers in the merits of artificial intelligence? Far from it! There are a number of challenges and limitations that are not necessarily new to quantitative investment managers, which may be aggravated by the flexibility of new techniques.

Artificial intelligence aims to extract relevant knowledge from possibly unstructured data on a self-learning basis. It works especially well for tasks with precisely defined rules and stable probability distributions, such as mastering demanding games like chess or Go. Machine learning tools also perform excellently in piloting self-driving cars, where the necessity to follow roads and traffic rules regulate the set of possible actions. However, the stochastic nature of financial markets with their lack of stable rules and probability distributions may challenge the validity of relationships that are learned from the past. Accordingly, models should always be applied to clearly defined problems and validated against sound theoretical assumptions.

Similarly, self-driving cars can be driven along the same roads as many times as is necessary to teach them all the relevant aspects of a journey and AlphaGo can play with itself until it perfectly masters the rules of the game. However, despite a seemingly abundant access to data, there is only one historical price trajectory for each financial market to train a model on. This limited data availability restricts the complexity of the artificial intelligence model that can be applied and, therefore, the flexibility of the model's output when forecasting future price movements. This problem is further deteriorated by the fact that the vast majority of data for financial markets has only been collected recently. As a consequence, researchers should focus on parsimonious model structures and not be misled by the mightiness of artificial intelligence models to adaptively learn the past.

Next, machine learning models excel at identifying relationships in data that may be unrecognizable to the human eye by revealing complex correlation structures. Still, they lack the causal reasoning and imagination that would be necessary to anticipate events that have not happened in the same way many times before. Would a trading model based on artificial intelligence have been able to predict the currency peg break between the Euro and the Swiss franc brought about by the Swiss National Bank in early 2015? Did quan- titative models foresee the taper announcement by the US Federal Reserve Bank in the spring of 2013? Most likely not. In a similar manner, machine learning algorithms may just find theories that are already well-known and proven. While this confirmation may add comfort, it may also just be a waste of time and money. So, despite increasing computer power and

Challenges for ML in asset management	Possible remedies
Lack of stable rules and probability distributions	– Apply models to clearly defined problems – Validate results against sound theoretical assumptions
Limited data availability	– Focus on parsimonious model structures – Account for mightiness of models to learn the past
Lack of causal reasoning and imagination	– Keep simplified transformation in mind – Diligent analysis before investing resources and modelling power
Future regulation and susceptibility to manipulation	– Check future accessibility of data sources – Validate contributors to data sources

Exhibit 5: Challenges and Possible Remedies
Source: Aquila Capital Concepts GmbH

data availability, it is necessary to keep in mind that quantitative models remain a simplified transformation of the world and will only have forecasting ability that is limited to specific tasks. Additionally, the complexity of calibrating artificial models requires a diligent analysis as to where to allocate resources and model power most effectively.

Other more general potential limitations include future regulation and susceptibility to manipulation. While the former may limit the use of data due to calls to protect privacy rights or fears of market infrastructure instability caused by black box models and automated trading processes, the latter may, for example, threaten the validity of contaminated information retrieved from fake social media user accounts or blogs posted by manipulated chatbots. It is worth checking the likely future accessibility of a data source and the way it is comprised before basing investment models on it.

Conclusion

This research note is aimed at providing a framework for assessing the opportunities and challenges of artificial intelligence methods within a structured investment process. It highlights that machine learning tools, owing to their adaptivity and self-learning capabilities, may add value along the entire value chain of an asset manager in two specific ways. First, by more effectively using currently available data based on algorithms that learn to reveal new, nonlinear relationships or by transforming data into representations with more interpretable meanings. Second, by embracing new data sources that provide additional information, for example, based on news flow and blog posts. However, the inherently flexible nature of machine learning methods is also their biggest challenge. It requires that the methods are put in the right context and thoughtfully applied so as to solve questions in a way that produces meaningful outcomes. It would be illusory to believe that artificial intelligence can develop a profitable investment rationale on its own. Accordingly, we are convinced that machine learning will most likely not turn out to be a holy grail, but that it will help quantitative investment managers in further improving their allocation processes. Nevertheless, the use of artificial intelligence in asset management is undoubtedly still at an early stage. This research note, consequently, provides evidence based on first experiences, but no final results. We are looking forward to an exciting future.

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Urs Schubiger has comprehensive experience in the research, development and implementation of quantitative investment strategies as well as leading business development initiatives. Prior to founding prime Capital and Achievement AM's Swiss subsidiary, he held senior positions at leading companies including Vescore Ltd, 1741 Asset Management Ltd, Wegelin & Co. Private Bankers and UBS O'Connor. Mr Schubiger holds master's degrees in Mathematics from the ETH Zurich and in Law from the University of Basel.

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Infrastructure and the Economy

Declan O'Brien
UBS

This series explores some of the key portfolio considerations of investing into infrastructure. Our first paper focused on the growing area of infrastructure debt. This paper, the second in our series, takes a closer look at how infrastructure returns might perform under various economic scenarios, and in particular in a rising interest rate environment. We use public and private infrastructure indices from 2004-2017 to help inform the analysis.

- In the current economic environment, solid GDP growth and increasing inflation expectations are putting pressure on central banks to raise interest rates.
- Although rising interest rates negatively impact infrastructure returns, faster GDP growth and rising inflation are both positive for infrastructure performance. We would therefore expect a moderate rise in interest rates to be largely offset by accelerating GDP growth or higher inflation.
- Infrastructure returns in periods of rising real interest have historically been below average (-12% p.a. versus 2004-17 average); however, returns remained positive at 10.1% p.a.
- Infrastructure owners have been putting long-term facilities in place to lock-in low financing costs. This is a structural change from previous cycles that could mitigate the impact to the sector of rising real rates.
- Infrastructure is often referred to as a bond proxy. During 2004-2017, infrastructure performed best relative to listed equities when either GDP growth was below average or real interest rates were falling; this is also

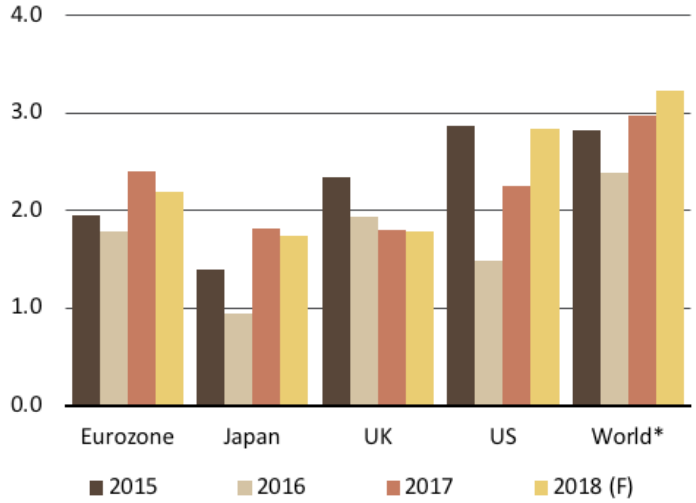

Exhibit 1: Strong Global GDP Growth in 2017
Source: Oxford Economics, March 2018

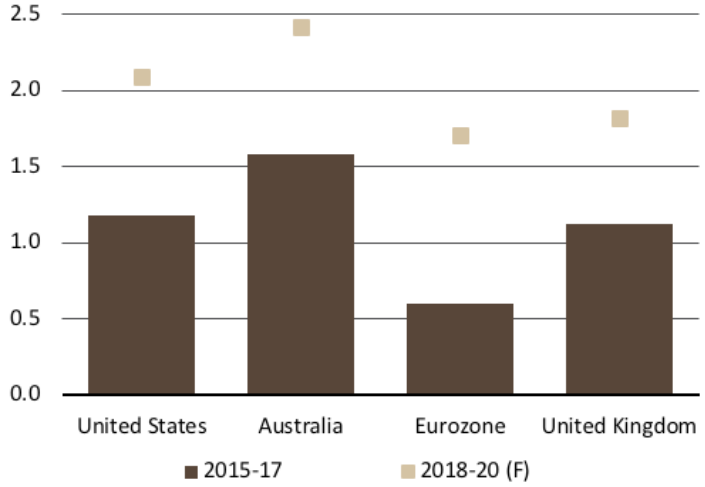

Exhibit 2: Forecast for Higher Inflation
Source: Oxford Economics, March 2018

when bond returns performed best.

- The bond-like features of infrastructure, combined with the yield pick-up versus fixed income, were key factors supporting the significant inflows into the asset class over the past decade. During 2004-17, listed equities outperformed infrastructure when real rates were rising or GDP growth was above average. Investors' appetite for additional infrastructure allocations in such environments could be reduced.

Overview

The global economy is experiencing a period of synchronized growth and inflation is picking-up; these trends, if continued, will result in continued tightening of monetary policy. In a Preqin survey of investment consultants covering infrastructure, rising interest rates ranked highest among their investment concerns.

In this paper, we examine how infrastructure returns might respond in different economic environments. We access the potential impact on infrastructure investment by, firstly, identifying the key cashflow drivers by infrastructure sub-sector and evaluating how sensitive these drivers are to changing economic variables.

Secondly, we analyze data from public and private markets to test how the asset class has performed historically under certain economic scenarios. Finally, we investigate investor sentiment towards the infrastructure asset class, and look at how capital inflows could be impacted under these scenarios.

In the wake of the financial crisis central banks around the world cut interest rates to record lows; however, weaning the economy off low interest rates will not been straightforward. Two tailwinds are now supporting a tightening of monetary policy: strong GDP growth and increasing inflation expectations (see Exhibit 1 and 2).

Sovereign bonds yield have already begun to adjust upwards to reflect these trends (see Exhibit 3), and forecasts suggest further increases ahead, although rates should remain low by historical standards.

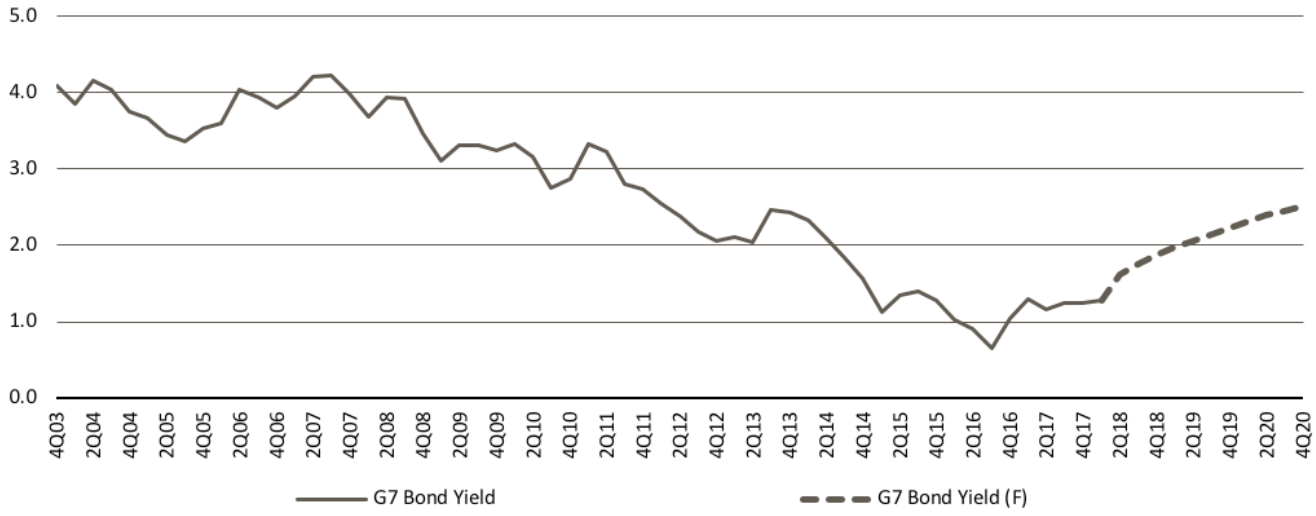

Exhibit 3: G7 Bond Yields[1] (nominal) (%)
Source: Oxford Economics, March 2018

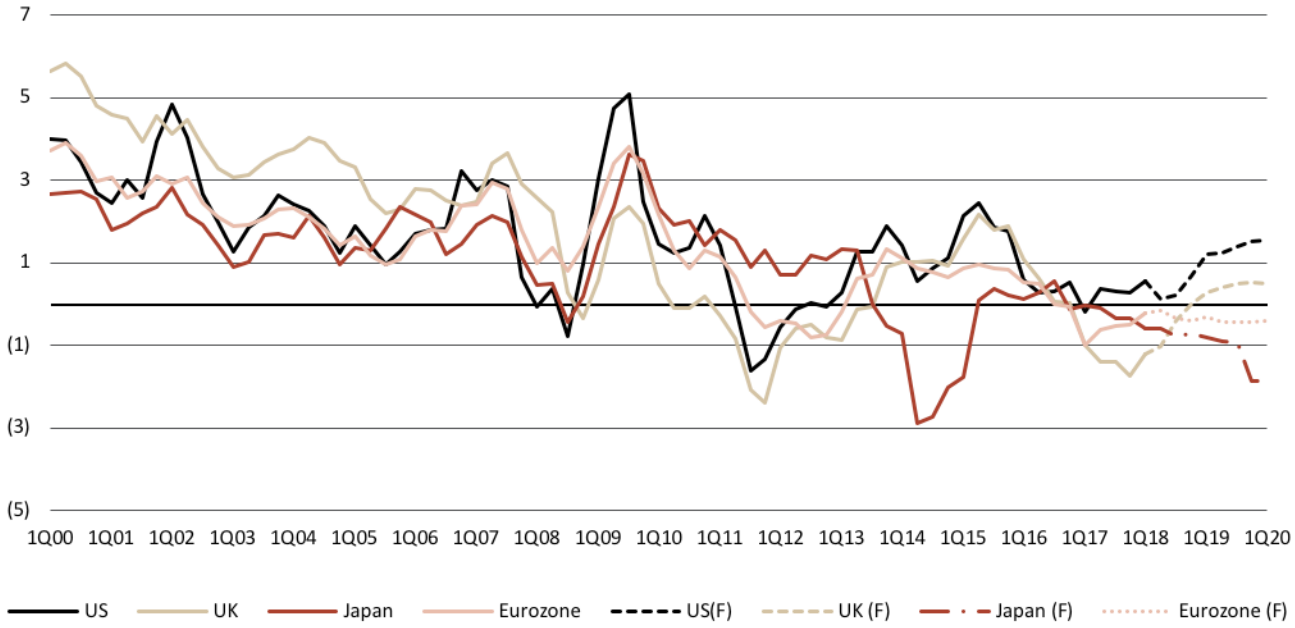

Exhibit 4: Real Interest Rates (%)
Source: Bloomberg, Oxford Economics, March 2018; historical data based on 10-year swap rates; forecast based on 10-year forward rates; Inflation = Consumer Price Inflation

In order to better understand the potential implications of rising interest rates for infrastructure investors, it is important to not just focus on nominal interest rates, but also on the components of nominal interest rates; i.e. the real interest rate and inflation expectations.

Once adjusted for inflation, rate rise expectations become more muted (see Exhibit 4). Markets expect the Federal Reserve to raise rates three to four times in 2018; however, we would expect interest rate normalization to be more gradual in other regions.

How will infrastructure returns perform in a rising rate environment?

This is not a straightforward question to answer. It depends on whether we refer to the performance of the cashflows, i.e. absolute performance or the attractiveness of the sector relative to other asset classes. We seek to provide some insights by applying a three-pronged approach:

- Identify the **cashflow drivers** for each infrastructure sub-sector and observe how we believe these assets will perform under different economic scenarios, based on typical asset features and contractual structures;
- **Analyze the historical performance** of listed and unlisted infrastructure from 2004 to 2017 to see if our observations in step 1 can be corroborated through the data; and
- Evaluate the drivers behind the record investor appetite for infrastructure, and **how elastic demand is to changing economic conditions.**

Cashflow Drivers

Rising interest rates seldom occur in isolation, and are typically a response to either strong GDP growth or inflation. We have set out below an illustration of how we would expect infrastructure cashflows to respond in such environments by infrastructure sub-sector.

Given the plethora of regulatory regimes across the world, we have simplified the analysis by focusing on a typical European asset in each sub-sector.

The impact of rising interest rates will ultimately depend on the capital structure of the investment, for example, the floating-fixed ratio of its debt and the level of exposure to refinancing risk. As rates have been at record lows for a prolonged period, many infrastructure owners have already put in place long-term financings to lock in lower rates. This should help mitigate the performance impact of the infrastructure sector from rising rates.

As illustrated below, rising inflation should increase revenues in most sectors, especially utilities and social infrastructure. Transportation assets should benefit most in a rising GDP growth environment.

The illustration below demonstrates the need to consider interest rates, inflation and GDP growth in their totality in order to understand the impact of rising interest rates. In the current environment where inflation and GDP growth are expect to increase, and capital structures have been de-risking, we expect the impact of rising interest rates on the infrastructure sector to be marginal.

	GDP growth	Rising inflation	Tightening monetary policy
Transport 	☑ Strong correlation between GDP growth and transportation assets with traffic risk	☑ Most tariffs are linked, or can be adjusted, with inflation	☒ Mostly negative; impact dependent on debt structure = Recoverable in some cases through cost of capital adjustment
Social 	= Limited impact as assets typically for social purpose	☑ Most tariffs are linked to inflation so revenues should increase in line with inflation	☒ Marginal impact as most existing projects have long-term debt ☑ Projects with large cash reserves will benefit
Energy 	☑ Power demand and price should increase with economic growth However, the impact of renewables and energy efficiency has reduced historical correlation	☑ Power purchase agreements and renewable subsidies typically increase with inflation Power prices should increase but not mechanically, and costs may rise with inflation	☒ Mostly negative; impact dependent on debt structure
Utilities 	= Regulated utilities' revenues not highly correlated with GDP ☑ Unregulated utilities should benefit as per power assets above	☑ Most tariffs are linked to inflation, so revenues will increase with inflation	☒ Mostly negative; impact dependent on debt structure Regulated utilities may be able to recover through cost of capital adjustments (with a lag)
Communications 	☑ Revenues should increase with economic activity, although unregulated business is experiencing pricing pressures	☑ Tariffs typically increase with inflation	☒ Mostly negative; sector typically financed with shorter-term debt

Analysis of Historical Performance (2004-2017)

Infrastructure data

The issues around the quality of infrastructure data are well documented. We set out the detailed sources used in the analysis in the Appendix. For listed infrastructure, we use the Dow Jones Brookfield Global Infrastructure Index and its sub-sector indices; however, we note that the index has a higher proportion of transportation and telecommunication assets than we would expect to see in a typical unlisted infrastructure portfolio.

We, therefore, do not provide a comparison of the performance between listed and unlisted infrastructure. Nonetheless, the results of how both listed and unlisted infrastructure respond under economic conditions, both on an absolute return level and relative to listed equities, provide valuable insight into the return drivers for the asset class.

Our analysis of the infrastructure assets class focuses on three variables: (1) GDP growth; (2) inflation and (3) interest rates. For each variable we chart the returns for each asset class (in columns), and also mark the average growth rate (2004-2017) to show the relative impact of each variable on the asset class.

Infrastructure returns in above/below average[2] GDP growth environments

Above average GDP growth
Exhibit 5a shows listed and unlisted infrastructure returned 14.4% p.a. and 12.9% p.a., respectively, in above average GDP growth environments, among the highest absolute values under all economic scenarios tested (see Appendix).

Listed equities also performed strongly (14.8% p.a. vs. average of 8.5% p.a.) with returns of 74% above average annual rates, and comparatively better than listed and unlisted infrastructure with improvements of 25% and 32%, respectively.

Below average GDP growth
Conversely, absolute returns for infrastructure ranked lowest in environments where GDP growth was below average (see Exhibit 5b).

However, relative to listed equities, both listed (1.3% p.a.) and unlisted infrastructure (-1.4% p.a.) significantly outperformed listed equities (-12.6% p.a.) in low GDP growth rate environments.

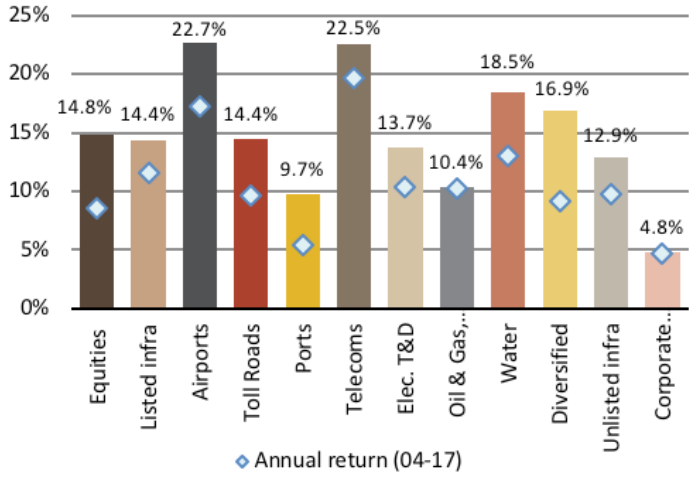

Exhibit 5a: GDP growth above average[3]
Source: Oxford Economics, March 2018

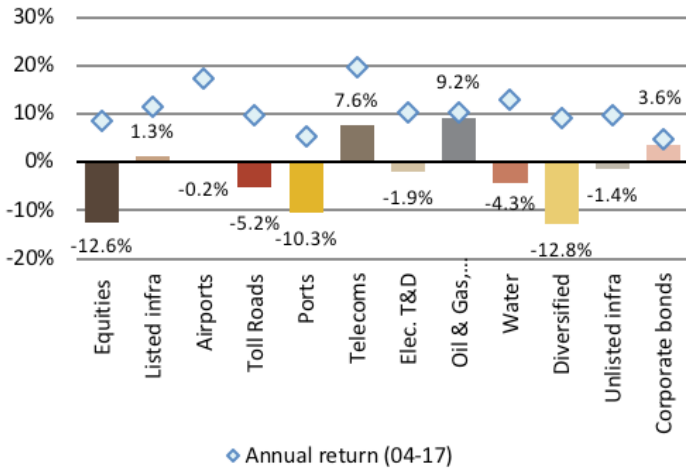

Exhibit 5b: GDP Growth Below Average
Source: Oxford Economics, March 2018

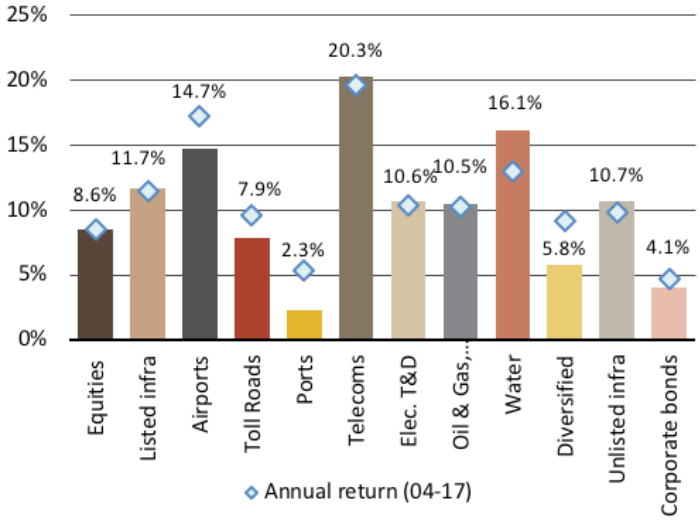

Exhibit 6a: Inflation[4] Above Average
Source: Oxford Economics, March 2018

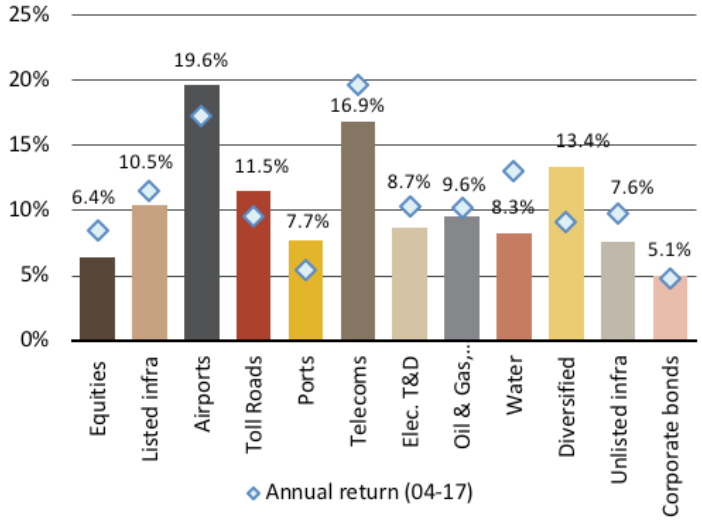

Exhibit 6b: Inflation Below Average
Source: Oxford Economics, March 2018

Infrastructure returns in high/low inflation environments

The correlation between infrastructure returns and inflation is relatively weak and does not appear to have a meaningful impact on absolute returns.

Given revenues are contractually linked to inflation for many infrastructure assets, the results were somewhat counter-intuitive.

We believe this is due to the timing impact of inflation. Where contractual and regulatory mechanisms exist within infrastructure assets, most adjust for inflation at the end of the year/with a year's lag. Therefore, we adjusted the test by lagging earnings by one year. This resulted in a stronger correlation and the results better reflect our understanding of how the asset class should behave (see Exhibits 7a and 7b).

Above average inflation
Absolute returns for listed (18.9% p.a.) and unlisted infrastructure (14.4% p.a.) when inflation was above average ranked highest out of the scenarios that we tested (see Appendix).
Listed equities also performed well during high inflation periods (14.3% p.a.), so no material outperformance was noted.

Below average inflation
When inflation was below average, both infrastructure and equities returned significantly below average; however, on a relative basis, infrastructure outperformed equities in a low inflation environment.

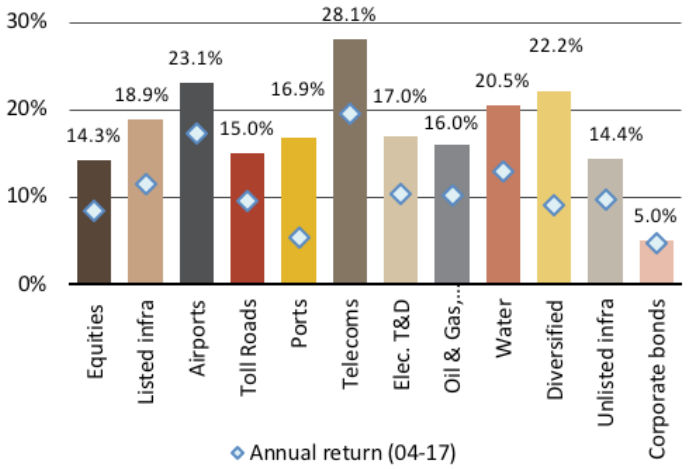

Exhibit 7a: Inflation Above Average (1-year lag)
Source: Oxford Economics, March 2018

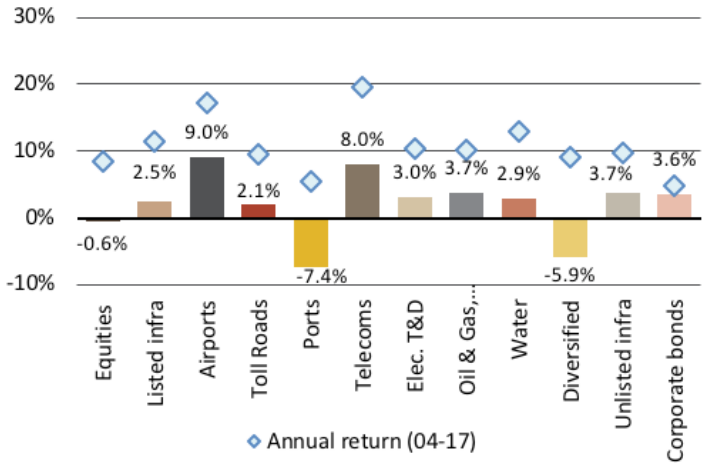

Exhibit 7b: Inflation Below Average (1-year lag)
Source: Oxford Economics, March 2018

Infrastructure returns in rising/falling real interest rate[5] environments

Rising real interest rates
On a nominal basis, returns for both listed and unlisted infrastructure performed better than their average. As discussed in the introduction, nominal interest rates typically rise as a response to faster GDP growth or inflation, both of which are positive for infrastructure returns.

Returns for listed infrastructure when real rates were rising were 10.1% p.a. (12% p.a. below average returns) whereas listed equities returns were 10.4% p.a. (22% p.a. above average returns).

Falling real interest rates
Listed infrastructure returned 12.9% p.a. (vs. average of 11.5% p.a. or 12% above average) in periods of falling real rates, a significant outperformance versus listed equities which performed 31% p.a. below average.

This outperformance reflects the benefit of either falling real rates or rising inflation on infrastructure investments. The positive impact of falling real rates reflect the fact that infrastructure asset are typically highly levered.

Observations

Infrastructure performs very well in falling real interest rate environments; however, returns for listed infrastructure in periods where real rates were rising were still positive with 10.1% (vs. average of 11.5%). The interest rate scenario was the only scenario tested where listed and unlisted infrastructure behaved materially differently. This is potentially due to different country exposures of the listed and unlisted indices.

The impact of interest rates on infrastructure depends on the capital structure of the investment. Given the prolonged low interest rates environment, the trend has been for infrastructure owners to de-risk the capital structure by putting in place long-term facilities to lock-in low rates. As a result, the performance impact of rising real rates on infrastructure could be very different from historical cycles.

Additionally, unlisted infrastructure valuations may be less impacted by the higher increasing interest rates as independent infrastructure valuations tend to use a "normalized" rate to adjust for ultra-low rates.

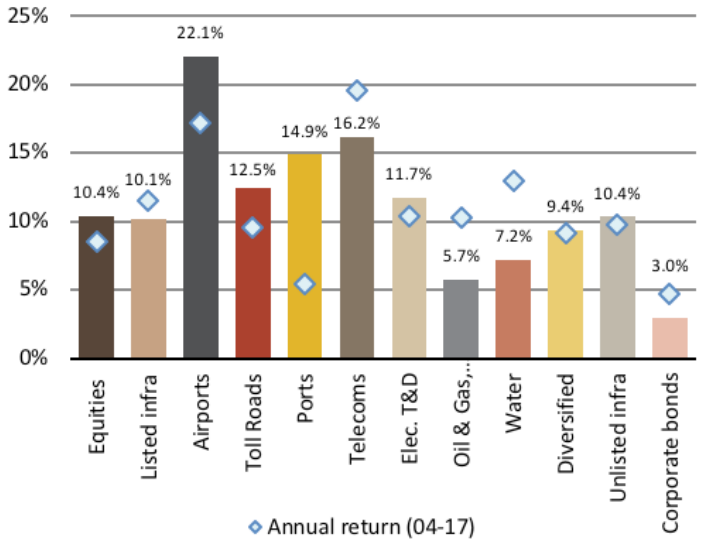

Exhibit 8a: Rising Real Interest Rates (%)
Source: Oxford Economics, March 2018

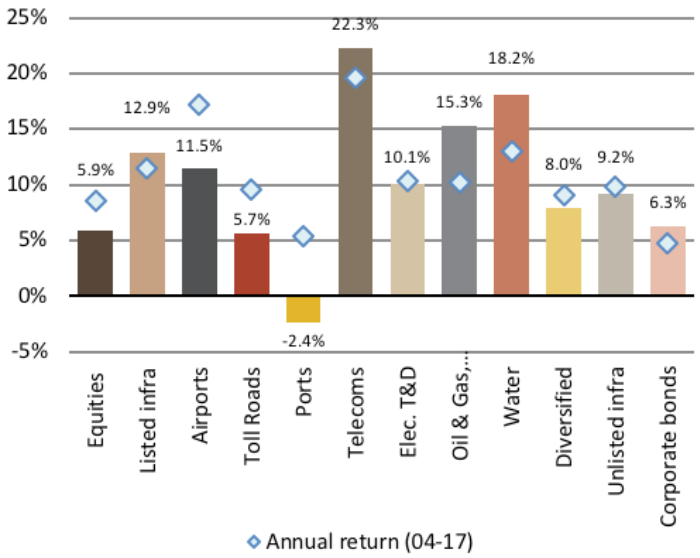

Exhibit 8b; Falling Real Interest Rates (%)
Source: Oxford Economics, March 2018

Key takeaways from historical performance analysis

GDP growth
On an absolute basis, infrastructure performed best in high GDP growth environments; however, relative to listed equities, it performed best in low GDP growth environments.

Inflation
Infrastructure performs well in periods of high inflation (assuming a lag), demonstrating that the asset class can provide protection against rising inflation.

Interest rates
Infrastructure performed well when real rates were falling, owing to the leverage inherent at asset level, and inflation protection.

These takeaways support the earlier observations in Section 1 around how we would expect infrastructure assets to behave based on asset features and contractual structures, i.e. strong correlation with rising GDP growth and inflation, but to be negatively impacted by real rates rises.

Attractiveness of the Asset Class

Infrastructure is often referred to as a bond proxy, and the performance of the asset class through the cycle may help to explain this: bonds and infrastructure both performed well relative to equities in periods of low GDP growth and falling rates environments (see Appendix).

The infrastructure asset class continued to receive strong new inflows in 2017 (see Exhibit 9). The bond-like features of infrastructure, combined with the yield pick-up versus fixed income, were key factors supporting the strong inflows into the asset class over the past decade.

While investment consultants are worried about interest rates, the attractiveness of infrastructure for investors is still high with 90% of investors expecting to deploy at least the same capital over the next 12 months; 93% of investors surveyed felt infrastructure had met or exceeded their expectations, a large increase from previous years.

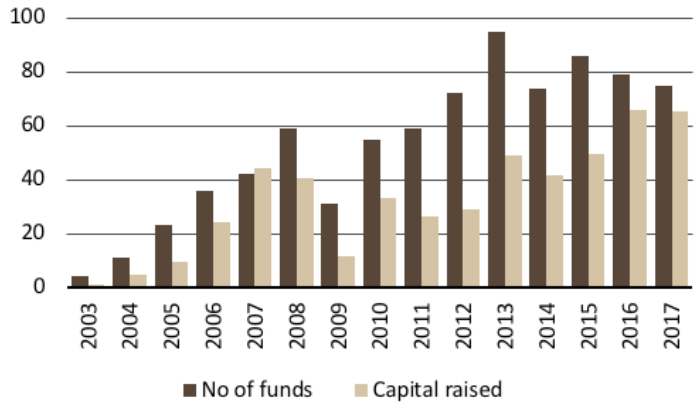

Exhibit 9: Significant Flows into Infrastructure
Source: Prequin, 2018

Conclusion

Overall, we expect nominal interest rates to increase as economies finally recover from the global financial crisis; however, the process should be gradual and real rate increases should be more muted.

The revenue structure for a typical infrastructure asset should respond to increasing GDP growth and inflation. This is also shown in the historical data (2004-2017), where GDP growth and inflation (with a lag) are strongly correlated with infrastructure returns. We would threfore expect the absolute performance of infrastructure to be robust in such an environment.

Investor sentiment towards the asset class is positive and infrastructure will continue to play an important part in diversifing investors' portfolios. Future allocations to the asset class will ultimately be determined by the realtive performance of infrastructure to listed equities and other asset classes.

Endnotes

1. 10-year bond yield for G7 countries equally weighted.
2. Average real GDP (Q1 2004 to Q3 2007) for G7 countries, equally weighted.
3. Weighted average GDP for G7 countries from Q1 2004-Q3 2007. Asset class sources are detailed in Appendix.
4. Inflation is the G7 weighted average Consumer Price Inflation (CPI).
5. Real interest rates uses the G7 weighted 10-year bond yield and subtracts inflation (CPI).

Appendix - Summary table

Macro scenario	Equities	Listed infra	Airports	Toll Roads	Ports	Telecoms	Elec. T&D	Oil & Gas, transport	Water	Diversified	Unlisted infra	Corporate bonds
Annual return (04-17)	8.52%	11.50%	17.25%	9.61%	5.40%	19.60%	10.35%	10.26%	13.01%	9.13%	9.78%	4.75%
Rising real yield	10.4%	10.1%	22.1%	12.5%	14.9%	16.2%	11.7%	5.7%	7.2%	9.4%	10.4%	3.0%
Falling real yield	5.9%	12.9%	11.5%	5.7%	-2.4%	22.3%	10.1%	15.3%	18.2%	8.0%	9.2%	6.3%
Rising nominal yield	19.8%	15.4%	35.1%	17.7%	38.1%	24.7%	12.3%	12.6%	15.5%	25.1%	12.1%	3.8%
Falling nominal yield	3.1%	10.5%	11.3%	8.4%	-5.9%	18.0%	10.0%	10.8%	13.0%	5.9%	8.5%	5.2%
Above average GDP growth	14.8%	14.4%	22.7%	14.4%	9.7%	22.5%	13.7%	10.4%	18.5%	16.9%	12.9%	4.8%
Below average GDP growth	-12.6%	1.3%	-0.2%	-5.2%	-10.3%	7.6%	-1.9%	9.2%	-4.3%	-12.8%	-1.4%	3.6%
Above average inflation	8.6%	11.7%	14.7%	7.9%	2.3%	20.3%	10.6%	10.5%	16.1%	5.8%	10.7%	4.1%
Below average inflation	6.4%	10.5%	19.6%	11.5%	7.7%	16.9%	8.7%	9.6%	8.3%	13.4%	7.6%	5.1%
Above avg inflation (lag)	14.3%	18.9%	23.1%	15.0%	16.9%	28.1%	17.0%	16.0%	20.5%	22.2%	14.4%	5.0%
Below avg inflation (lag)	-0.6%	2.5%	9.0%	2.1%	-7.4%	8.0%	3.0%	3.7%	2.9%	-5.9%	3.7%	3.6%

result for asset class under economic variable is 10% (or more) above equities (using delta from average returns, see note for methodology)
result for asset class under economic variable is 10% (or more) below equities (using delta from average returns, see note for methodology)

Note: The figures used in the above calculation (red/green illustration) correspond to the performance of the asset class under the specific economic variable relative to its respective annual return (04-17). For example, under the "Above average GDP growth" scenario, listed infrastructure returns were 25% above the average annual rate (14.4%/11.5% - 1); **49% lower** than the returns for equities of 74% (14.8%/8.5% - 1), so the result is highlighted red as listed infrastructure underperforms equities by more than 10%. This analysis is provided for illustration only.

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Declan O'Brien is a Senior Infrastructure Analyst in the Research & Strategy team, which forms part of Real Estate & Private Markets within UBS Asset Management. Declan joined UBS-AM's business in October 2017 and is based in London. In this role, he is primarily responsible for providing quantitative and qualitative cross-regional analysis of infrastructure investment markets. Declan joined from Legal & General Investment Management (LGIM) (2015–2017), where he was responsible for LGIM's research and strategy in the infrastructure sector. His previous roles were Assistant Vice President – Infrastructure with Moody's Investors Services in London and Madrid (2009-2015), where he covered credits across the energy, transportation and telecommunications sectors; and at KBC Bank N.V. in Dublin and Sydney (2004-2008), where he structured and originated project finance transactions. Declan is a member of the ACCA.

The Evolution of Target Date Funds: Using Alternatives to Improve Retirement Plan Outcomes

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Defined contribution (DC) plans are increasingly becoming the primary retirement vehicles for many workers. These plans allow participants to defer income on a tax-advantaged basis through retirement. According to Willis Towers Watson's 2017 Defined Contribution Plan Sponsor Survey, 81% of sponsors offer only a DC plan to new hires. This is a shift from the original intent of DC plans as a supplement to the more secure defined benefit (DB) plans, which provide a specified benefit at retirement regardless of how the underlying plan investments perform as the employer absorbs gains and losses. With DC plan accounts, participants keep the investment earnings and absorb the investment losses. This change creates new retirement risks for U.S. workers. Consequently, DC plans require sponsors to invest more resources to assist participants in achieving successful retirement outcomes. Now more than ever, DC plans have wide-reaching implications on the retirement readiness of participants.

The migration from DB to DC plans shifts the investment risk and reward from the sponsor to the participant. With this changing responsibility, it is important to port the best practices from DB plans over to the DC marketplace. This has historically been a challenge on the investment side as DC participants determine which underlying funds and investment managers to select to meet their objectives, often resulting in money moving in and out of funds daily.

DB plans, on the other hand, have sponsor-directed investments where managers are hired to achieve long-term objectives with less day-to-day cash movement. As such, DB plans have been able to invest in alternative investments, which offer exposure to assets that can produce more attractive returns while diversifying the risk from public equities (direct ownership in public companies) and fixed income (debt contracts from companies and governments); however, alternative investments also

come with complexities that have been historically difficult to implement in DC plans, such as less liquidity (ability to convert securities to cash) and less frequent pricing.

Corporate DB plans outperformed DC plans by an average of 70 basis points[1] (bps) net of fees per year between 1990 and 2012.[2] For the 10 years ended in 2016, DB plans saw annualized net returns of 5.4% compared with DC plans' annualized net returns of 4.9%, for a net return difference of approximately 50 bps.[3] Much of this dispersion is a result of asset allocation.

As of 2016, the largest corporate pension plans in the Fortune 1000 (assets greater than $2.1 billion) held average allocations of 4.2% to hedge funds, 3.4% to private equity, 3.0% to real estate and 3.6% to "other" asset classes.[4] That is almost 15% on average in securities other than equities, bonds and cash. Furthermore, public pensions allocate even more to alternative investments (approximately 25%) according to the National Association of State Retirement Administrators.[5]

DC plan investors have relied primarily on investment vehicles that allow for daily liquidity — which translates to mostly publicly traded equities and fixed income. Entering 2018, all-time highs were being achieved in the equity market almost daily. Equities have increased in value by over 300% since the financial crisis of 2007 to 2008. The key for plan sponsors is to look ahead to better protect their participant portfolios against the inevitable drawdown that always occurs when the equity markets turn the other way.

While the construct of DC plans has not changed over the years, what has changed are the typical investments utilized by participants, specifically, target date funds (TDFs). TDFs aim to help participants through the somewhat daunting task of determining which asset classes and managers to allocate to by creating portfolios that include multiple asset classes, labeled by a participant's intended year of retirement.

For example, a participant who plans to retire in the year 2030 can invest 100% of his or her assets in the "2030 fund," which consists of a mix of equities, bonds and potentially other asset classes whose mix changes to lower the risk level as the participant approaches retirement. Given that the participant does not need to make decisions about the composition of the TDF portfolio itself, TDFs represent a unique vehicle to potentially access the alternative strategies that have long benefitted DB plans.

This paper examines:

- The growing use of TDFs in DC plans
- How the use of alternative investments such as private equity, real estate and hedge funds can provide value to TDF solutions
- How TDFs can manage the liquidity, rebalancing and cash flows to accommodate these kinds of investments
- How allocations to these different asset classes affect projected outcomes when compared with a traditional TDF asset allocation

We conclude that advancements in the capabilities of DC plan sponsors and providers now make significant investment portfolio construction advancements possible.

Progress Made in Plan Design and Communication, but Enhancing Investment Opportunities Remains Critical

Plan sponsors have prioritized actions intended to improve participation in their DC plans in recent years, and the results have been positive and dramatic:[6]

- Plan design changes to encourage saving using auto-enrollment, auto-escalation, and new or revised employer matching contributions have increased plan participation rates and encouraged higher savings levels.
  - 73% of sponsors auto-enrolled versus 52% in 2009 with plan participation of 90% versus 68% for those who do not auto-enroll.
  - 60% of sponsors provide an auto-escalation feature in their DC plan, up from 54% in 2014.
- The expansion of Roth 401(k)s in 2017 to 70% of sponsors versus 46% in 2012 has provided participants with the ability to save for retirement on either a pre- or post-tax basis.
- More engaging communication, education and outreach efforts have helped participants take better advantage of the benefits offered.
- Many continue to simplify their investment fund menus allowing participants to better assess their options and make better decisions.
  - 42% of sponsors streamlined their lineups over the past three years versus 18% that added options to their lineups.
  - In 2017, only 15% of sponsors offered 20 or more options in their plan lineups versus 32% in 2010.

Nevertheless, increasing plan participation is only one of the ways to improve retirement income outcomes. Another perhaps even more important step is improving the performance of the underlying investments. The use of alternatives in DB plans is an investment practice that should be considered in today's DC plans, specifically in TDFs.

Growth of TDF Adoption in DC Plans: Building Better Portfolios

Many of the trends in DC plans revolve around the default investment for participant assets when the participant has failed to indicate where he or she would like to invest. Plan sponsors subject to the Employee Retirement Income Security Act of 1974 (ERISA) and utilizing a qualified default investment alternative (QDIA) as the default investment receive safe harbor protection for the investment decision from the U.S. Department of Labor.

Since the passage of the Pension Protection Act of 2006, there have been increasing flows into the default investments in plans that auto-enroll their employee populations.[7] Increasing auto-enrollment leads to increasing numbers of participants who do

not actively provide investment direction, and those assets tend to go to TDFs. In 2017, 93% of retirement plan QDIAs were TDFs versus 64% in 2009.[8]

Additionally, flows have been incredibly stable as TDF investors are often defaulted into the funds and do not reallocate their DC investments. Estimated flows have been strongly positive over the last 10 years not only at the total target date industry level but also in individual funds. For example, in 2017 all funds prior to retirement (2020 funds and those later dated) saw positive estimated flows while the in-retirement funds saw outflows.[9] Because of this combination, 49% of new contributions into DC plans are being invested into TDFs compared with just 8% in 2007.[10] While there may be sponsor-directed flows from target date funds, as in the shift from active to passive over the past few years, participant allocations have been very stable.

The growing popularity of TDFs presents the opportunity to build better portfolios within the TDF construct utilizing a custom approach. To be clear, alternative asset classes can potentially be utilized in the pre-packaged TDFs offered by asset managers in the marketplace today, but for the most part industry-wide usage of alternatives has been very limited because those asset managers do not have the internal expertise with alternatives. Therefore, if a sponsor wants to add exposure to alternatives today, building custom funds is the most effective approach.

Willis Towers Watson's 2017 Defined Contribution Plan Sponsor Survey found that custom implementations were increasing in the large plan market, with 38% of plans $5 billion or greater offering custom TDFs and 66% of plans offering custom core funds. This trend is partially due to improved technology and plan administrator capabilities in implementing custom funds, giving sponsors higher confidence in DC service providers' abilities to administer portfolios that include alternatives.

Range of Retirement Outcomes in a Typical TDF

For this analysis, the baseline consists of a passively implemented glide path with a typical risk level and de-risking path often seen in off-the-shelf implementations.[11] The glide path is a description of how the various funds that make up a target date product alter their asset allocation over time, moving from riskier assets focused on growth for younger participants into lower risk assets focused on income and capital preservation as retirement approaches. The glide path in this analysis consists of a consensus of 21 fund families that offer target date products to institutional clients.[12] The building blocks in the baseline include public equities (both U.S. and non-U.S.), real estate investment trusts (REITs), commodities, aggregate bonds, treasury inflation-protected securities (TIPS) and cash.

The glide path begins with approximately 91% of total assets categorized as "return-seeking." These are assets meant to generate return as opposed to those designed to lessen volatility of returns, and they consist of public equities, REITs and commodities in the baseline. The return-seeking allocation has decreased to 64% by 10 years to retirement, and to 45% at retirement, showing a consensus that material allocations to riskier assets (relative to risk-reducing asset classes) are still appropriate at retirement to support the long-term spending horizon in retirement. Exhibit 1 is a visual representation of the baseline glide path.

We also determined representative demographic and plan design information to model a "typical" DC participant. The modeled participant begins saving in the plan at age 25 with a salary of approximately $51,000.[13] Salary trends upward at inflation plus 2% through mid-career at which point the participant receives only cost of living adjustments through retirement. The participant saves 4.0% of salary when entering the plan, trending to 6.5% at

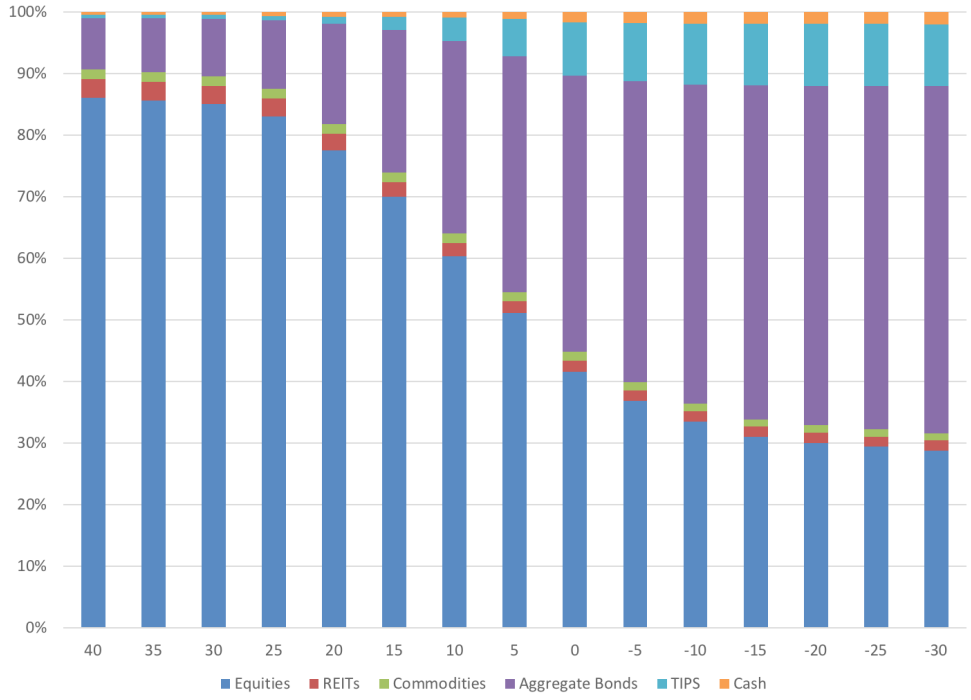

Exhibit 1: Baseline Glide Path

	Annual inflation-adjusted retirement income per $100,00 in pre-retirement annual wages
75th percentile	$77,000
50th percentile	$53,000
25th percentile	$36,300
5th percentile	$21,200

Exhibit 2: Distribution of Potential Retirement Income for a Full-career Employee

mid-career and 7.5% at late career.[14] The assumed employer match is 50% of the first 6% contributed to the plan,[15] and the assumed expected retirement age is 65.

As mentioned previously, the baseline glide path retains material exposure to growth assets at the point of retirement given that participants may remain invested in the TDFs and utilize their assets to generate lifetime income in retirement. As such, the typical TDF investor has a wide distribution of potential outcomes at retirement.

Retirement success is measured as the ability to create a stream of income in retirement through accumulating assets over a working career while invested in the baseline glide path. One example of how this can be accomplished is by converting simulated DC balances at retirement into inflation-adjusted lifetime annuities.

Exhibit 2 shows the amount of income that can be generated by converting a full-career employee's DC balance into a stream of income at retirement. In very bad scenarios (5th percentile) the DC plan may replace $21,200 or less per $100,000 of pre-retirement annual wages; in very good scenarios (75th percentile) it may replace $77,000 or more, but the expected outcome (50th percentile) is $53,000. This again highlights the shift in risk from sponsor to participant when moving from DB to DC. For example, certain DB plans provide retirement benefits based on factors such as ending salary and years of service. To illustrate, consider a DB plan that provides a benefit of 1.4% X (salary at retirement) X (years of service). If this participant worked for 35 years and had a final salary of $100,000, she would receive $49,000 per year in retirement regardless of how markets performed. Contrast this to the volatility in the potential DC outcomes and it is clear that any improvements to add stability to those outcomes is beneficial.

The retirement incomes were developed first by simulating a participant's working life over 5,000 paths. In each path, the full-career employee contributes to the plan, and other key variables fluctuate around their expected values such as salary growth, market returns and inflation. At retirement, the participant has 5,000 unique ending DC balances, which are converted into annuities. The annuity conversion factor is based on simulated interest rates and assumes a 3% annual inflation adjustment.

Expanding Opportunities, Reducing Complexity

The volatility in results is one reason DC sponsors, consultants and providers have focused heavily on the adoption of retirement income solutions in recent years to provide investment options and vehicles that can directly address the risk of poor outcomes by creating an income floor. Cost, complexity, portability, operational challenges and regulatory uncertainty are just some of the reasons retirement income remains a slow-moving trend, so improving investment efficiency by utilizing an expanded opportunity set in portfolio construction is an alternative route to improve the full distribution of outcomes (both median and downside). The growth of TDFs presents a unique opportunity to evolve the underlying building blocks within the TDF structure without increasing complexity for DC participants.

We explored whether including alternative investments within the TDF structure could not only improve median results but also narrow the distribution of outcomes. We note that our expectation would be that upside scenarios are lower under some of these alternative implementations given that public equities have relatively high upside potential. Foregoing strong upside results (e.g., when equities strongly outperform all other classes) to improve downside results is a reasonable objective given the evolving role of DC plans as primary retirement vehicles.

Including Alternative Investments Can Improve Retirement Income

When testing the potential inclusion of alternative investments in a TDF, we utilize the baseline glide path results discussed on the prior page as a benchmark. Our objective was to assess the use of alternatives in TDF structures not only directionally but also in terms of magnitude.

Adding Private Equity to the Glide Path

We start by considering the addition of private equity investments in the target date glide path. Understanding the characteristics of the alternative asset categories considered is critical as it informs where to source the assets for the strategic alternative allocation. For example, assets may come from all return-seeking assets, all risk-reducing assets, specific asset categories or a combination. The decision on where to source assets from is a function of the total fund objective and the purpose of adding the alternative investments.

While private equity does provide some diversification, it primarily seeks long-term outperformance versus public equity, and as such the private equity allocation is sourced directly from public equities. Exhibit 3 on the following page shows two glide paths utilizing private equity in their strategic allocations. The more conservative of the two begins with 10% of the public equity allocation invested in private equity, trending to 0% at retirement.

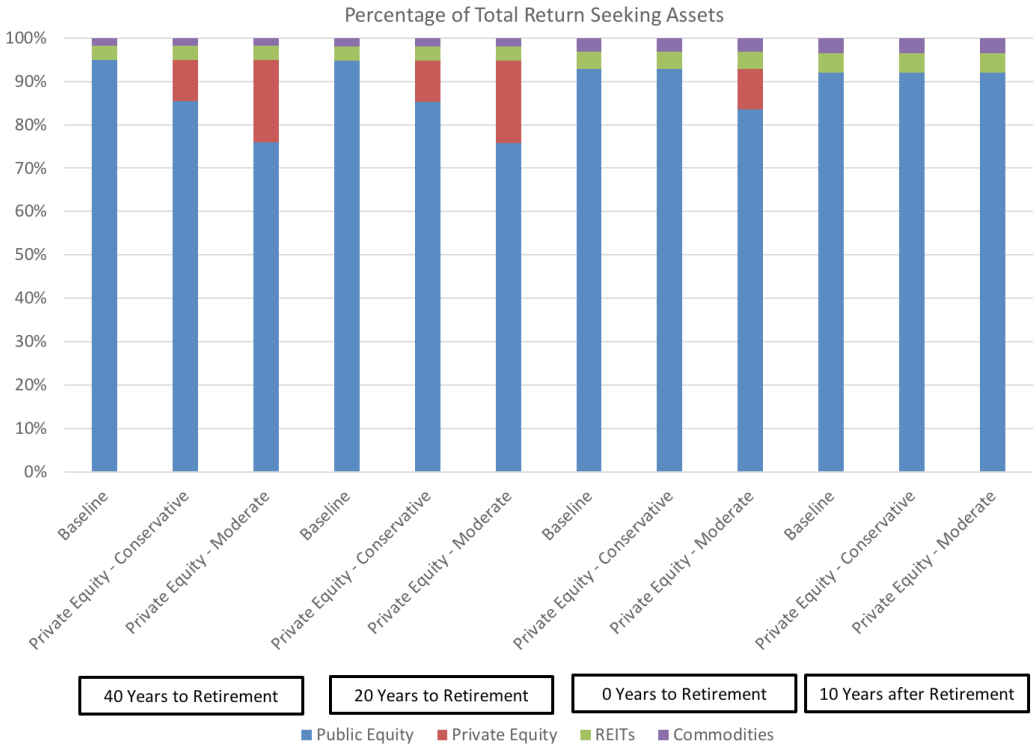

Exhibit 3: Percentage of Total Return-seeking Assets (Adding Private Equity)

The second glide path starts with 20% of the public equity allocation in private equity, trending to 10% at retirement and 0% by 10 years post-retirement.

The expected performance differential between the best-performing and average private equity managers is wider than in many other categories, and by its nature private equity is an asset class that would be actively implemented. Oversight and management of a private equity portfolio may be handled by the plan sponsor or with the assistance of an external partner; for this analysis, we assumed the implementation of high-skill/high-conviction managers. The active management component and the nature of the asset class also lead to higher fees. A typical fee structure includes a management fee charged on all committed capital in the range of 1.5% to 2.0% as well as a performance fee. Sponsors should be aware of these higher fees but should also note that the value received for fees — the net of fee results — is more relevant.

Implementing a private equity strategy within the TDF with high-skilled managers over a long time horizon improves the entire distribution of accumulation metrics. The ability to shift the distribution comes from broadening the investment opportunity set to include higher returning investments, which take advantage of participants' ability to bear investment and illiquidity risk. Younger participants are able to withstand the additional volatility of higher private equity weights given their long time horizons (low financial capital relative to human capital, or future earnings). As participants age the relative weighting to private equity decreases because market risk becomes a larger concern when participants transition into the retirement spending phase. These results, as with all of our analyses, assume that when participants experience large drawdowns in their accounts in any one period, they will remain in the TDF and not transfer assets out at an inopportune time. These behavioral assumptions are supported by data on how participants act when they are invested in TDFs (often as defaulters in auto-enrollment scenarios) where money tends to be "sticky."

	Annual inflation-adjusted retirement income per $100,00 in pre-retirement annual wages		
	Baseline	**Real estate - conservative**	**Real estate - moderate**
75th percentile	$77,000	$82,000	$88,400
50th percentile	$53,000	$56,100	$59,700
25th percentile	$36,300	$38,400	$41,100
5th percentile	$21,200	$22,400	$23,700

Exhibit 4: Distribution of Potential Retirement Income for a Full-career Employee

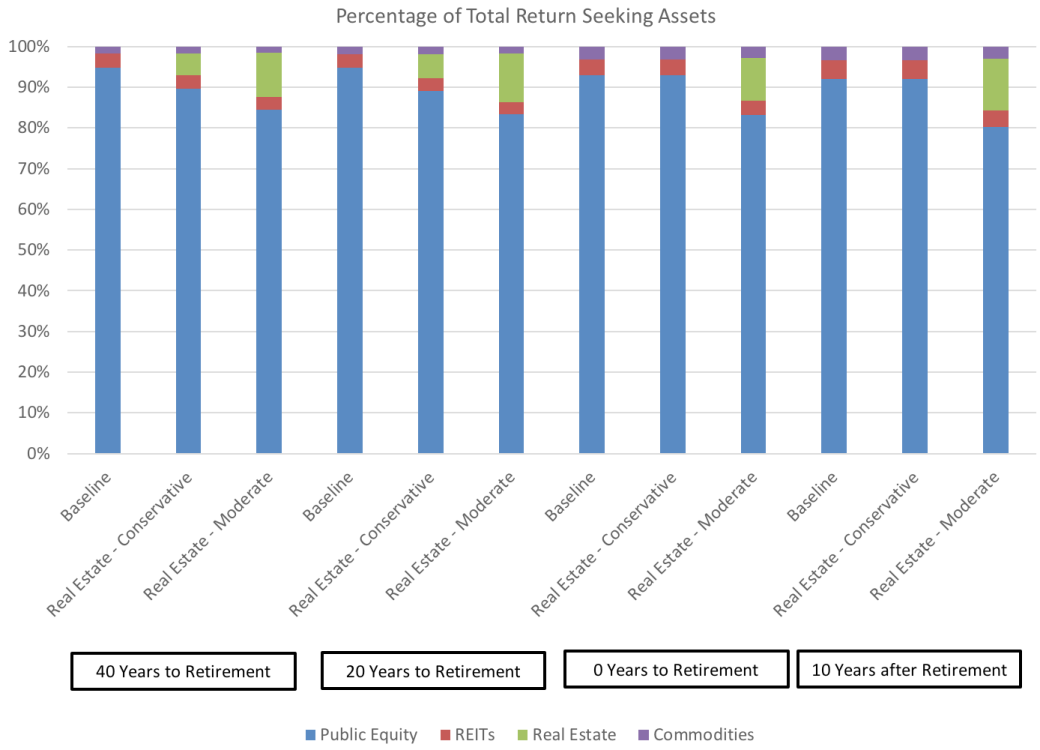

Exhibit 5: Percentage of Total Return-seeking Assets (Adding Real Estate)

Exhibit 4 shows that a full-career employee retiring with $100,000 in pre-retirement annual wages could be expected to have DC savings that would allow him or her to convert that DC balance into a $53,000 inflation-adjusted annuity using the baseline glide path. Implementing private equity at conservative and more moderate weights increases median (50th percentile) retirement income by 6% ($3,100) and 13% ($6,700), or $56,100 and $59,700 versus $53,000, while the downside (5th percentile) results are also improved by 6% ($1,200) and 12% ($2,500), or $22,400 and $23,700 versus $21,200, respectively, from the baseline.

Adding Core Real Estate to the Glide Path

Unlike private equity, which seeks to enhance expected returns, real estate offers diversification and downside protection. Therefore, unlike private equity, which is sourced from public equity allocations, real estate is sourced from both return-seeking and risk-reducing allocations. Core real estate offers both an income and capital appreciation component, and when sourced from the total portfolio it may be expected to reduce risk without a commensurate decrease in expected return.

As shown in Exhibit 5, the two glide paths tested were a more conservative implementation that allocated 5% of total assets to real estate, trending to 0% at retirement, and a more moderate allocation of 10% of assets, trending to 5% at and through retirement. The return-seeking and risk-reducing allocations were reduced pro rata in each of the scenarios.

Exhibit 6 shows that for a full-career employee, implementing real estate at conservative and more moderate weights leads to downside improvements of 2% ($400) and 3% ($600), or $21,600 and $21,800 versus $21,200, in retirement income for a participant with $100,000 in pre-retirement annual wages. The "cost" of this is a similarly modest reduction in median results. The takeaway is that over long time horizons implementing real estate is expected to have larger risk-reduction benefits (both in an absolute sense and more so in a relative sense) than reductions in expected case.

	Annual inflation-adjusted retirement income per $100,00 in pre-retirement annual wages		
	Baseline	**Private equity - conservative**	**Private equity - moderate**
75th percentile	$77,000	$75,900	$74,500
50th percentile	$53,000	$52,700	$52,600
25th percentile	$36,300	$36,600	$37,000
5th percentile	$21,200	$21,600	$21,800

Exhibit 6: Distribution of Potential Retirement Income for a Full-career Employee

Adding Hedge Funds to the Glide Path

Hedge fund strategies, by definition, include a broad opportunity set that may include both equity and fixed-income instruments. As such, we source the hedge fund allocation from both return-seeking and risk-reducing assets (similarly to how real estate was handled). Similar to private equity, the expected performance differential between the best-performing and average managers is relatively wide, and a hedge fund portfolio must be actively implemented. As such, we assumed the implementation of high-skill/high-conviction managers.

While we would similarly expect improved net-of-fee performance, the active management component and esoteric strategies used within hedge funds also lead to higher fees. A typical fee structure, like in private equity, includes a management fee in the range of 1.5% to 2.0% as well as a performance fee. Total fees can be managed through including some lower cost alternative beta[16] strategies in the implementation.

A skilled hedge fund portfolio can be implemented with higher liquidity than some of the other strategies we've discussed thus far, so strategic weights can be higher while still retaining the ability to manage the fund both in normal and stressed time periods. As shown in Exhibit 7, the conservative hedge fund implementation starts at 10% of the total fund and transitions to 5% at retirement, while the moderate implementation starts at 20% of the total fund and transitions to 15%. The return-seeking and risk-reducing allocations were reduced pro rata in each of the scenarios.

The nature of the underlying assets can have a material impact on results, so we again use our income replacement framework to evaluate these alternatives. While maintaining a portfolio of hedge fund managers requires heightened governance related to manager oversight and implementation, doing so successfully can improve the total distribution of outcomes during the accumulation phase.

As shown in Exhibit 8, on the following page for a full-career employee, implementing hedge funds at conservative and more moderate weights increases median (50th percentile) retirement income by 2% ($900) and 4% ($2,000), or $53,900 and $55,000 versus $53,000, while the downside (5th percentile) results are also improved by 4% ($800) and 8% ($1,700), or $22,000 and $22,900 versus $21,200, respectively, from the baseline.

While the previous examples look attractive in isolation, we now turn to considering how these strategies contribute to a diversified implementation that includes allocations to all these assets. Not only do these alternative asset classes provide diversification or differentiated return drivers relative to equities and fixed income, but they also provide attractive cross-correlation benefits when viewed in combination with each other (meaning they outperform and underperform at different times from one another). The next section examines the impact on results of implementing a diversified portfolio including alternative assets.

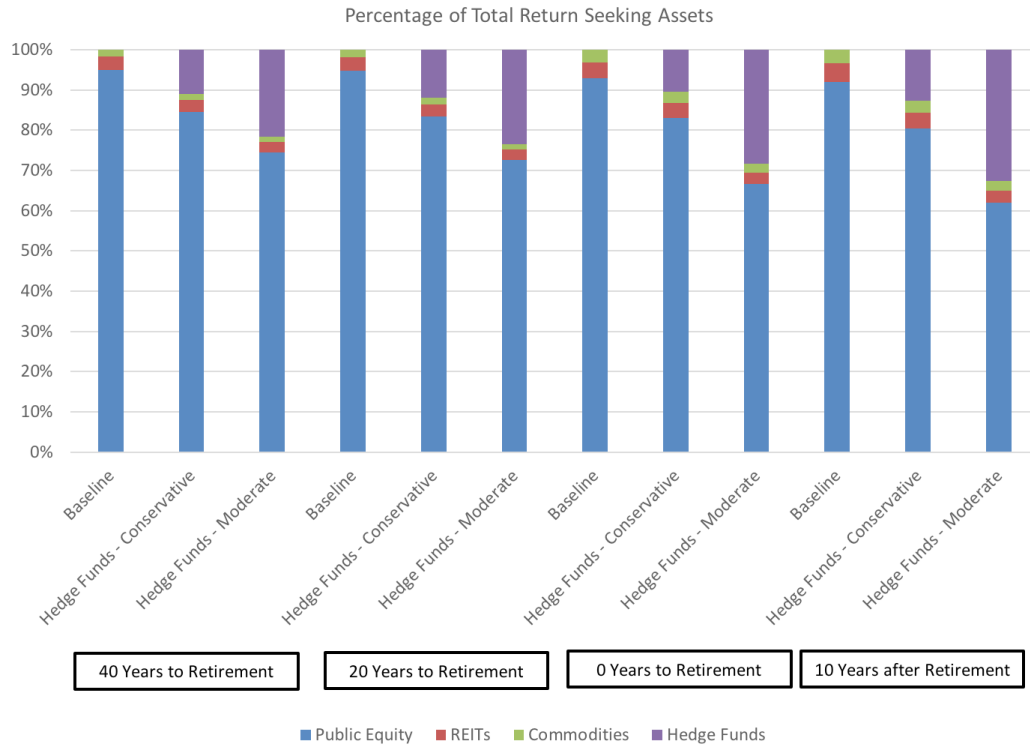

Exhibit 7: Percentage of Total Return-Seeking Assets (Adding Hedge Funds)

	Annual inflation-adjusted retirement income per $100,00 in pre-retirement annual wages		
	Baseline	**Hedge funds-conservative**	**Hedge funds - moderate**
75th percentile	$77,000	$79,200	$81,200
50th percentile	$53,000	$53,900	$55,000
25th percentile	$36,300	$37,800	$38,700
5th percentile	$21,200	$22,000	$22,900

Exhibit 8: Distribution of Potential Retirement Income for a Full-Career Employee

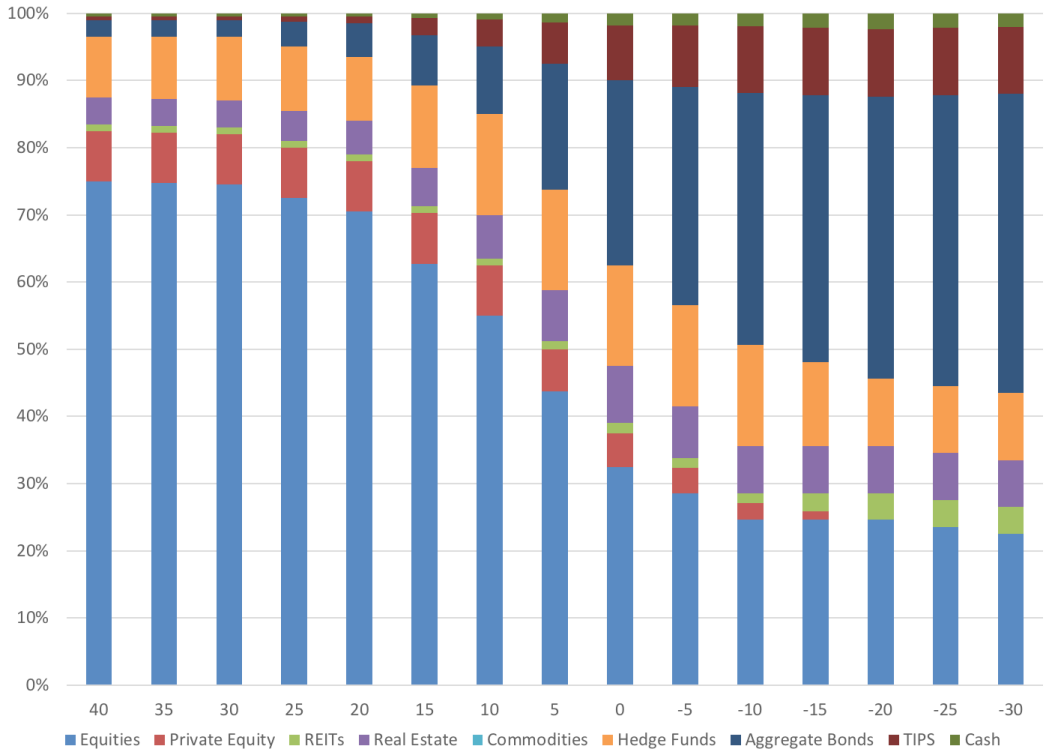

Exhibit 9: Diversified Glide Path

Adding a Combination of Diversifying Investments to the Glide Path

Exhibits 9 and 10 review a diversified implementation that utilizes alternative asset classes to a higher degree than any of the alternative glide paths previously reviewed. From a diversification of returns perspective, the total diversified portfolio is expected to have lower risk than some of the individual asset class glide paths considered in prior sections.

The diversified glide path starts at 97% return-seeking assets and trends to 63% at retirement versus 91% trending to 45% for the baseline. It may appear the diversified glide path is materially riskier than the baseline given that the glide path holds approximately 18% more return-seeking assets at retirement; however, the diversified portfolio holds only 33% in public equities (38% total when considering private equity as well) versus 42% for the baseline. This suggests potentially lower market risk for the diversified glide path, which was the main driver of results in recent stressed market environments (e.g., global financial crisis, dot-com bubble burst).

With the objective in mind of creating similar risk portfolios to the baseline, we produced a diversified glide path that improves median (50th percentile) retirement income by approximately 17% ($9,200) ($62,200 versus $53,000) for a full-career employee as shown in Exhibit 11, on the following page. The downside outcome (5th percentile) was also improved by 11% ($2,300) as the diversified glide path produced $23,500 in retirement income versus $21,200 for the baseline.

While the portfolios were constructed to be of similar risk along the glide path, the increased diversification provides risk benefits over time versus the baseline. While diversification is utilized marginally in the products offered today, there is still a lot of room to enhance DC participant outcomes through greater usage of alternative investments.

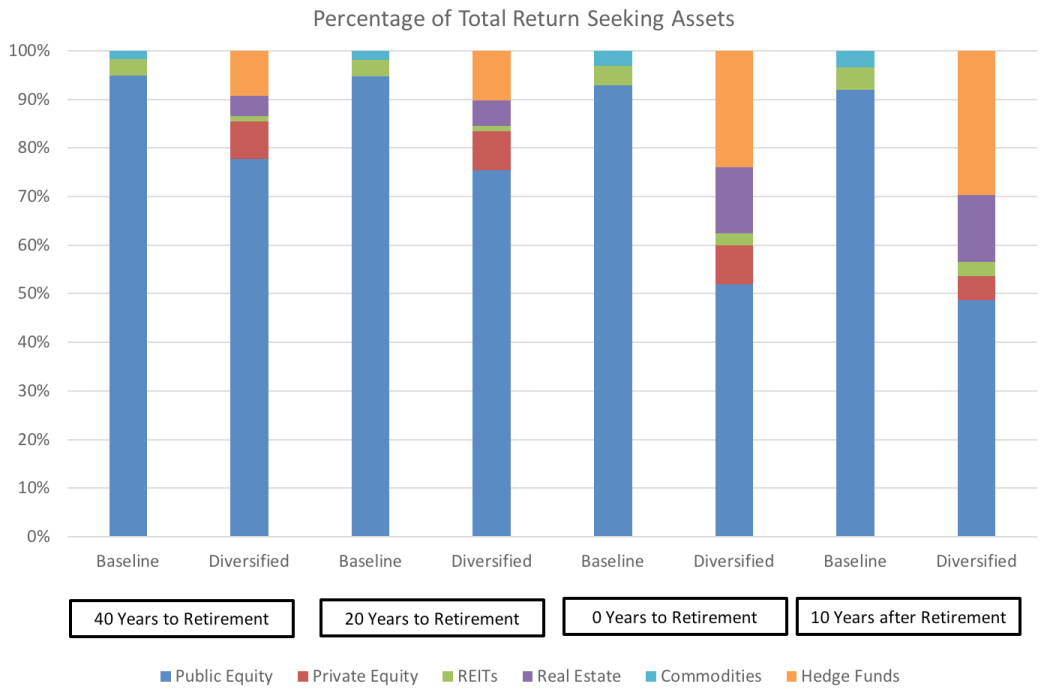

Exhibit 10: Percentage of Total Return-Seeking Assets

	Annual inflation-adjusted retirement income per $100,00 in pre-retirement annual wages				
	Baseline	**With private equity**	**With real estate**	**With hedge funds**	**Diversified glide path**
75th percentile	$77,000	$88,400	$74,500	$81,200	$93,900
50th percentile	$53,000	$59,700	$52,600	$55,000	$62,200
25th percentile	$36,300	$41,100	$37,000	$38,700	$41,900
5th percentile	$21,200	$23,700	$21,800	$22,900	$23,500

Exhibit 11: Distribution of Potential Retirement Income for a Full-career Employee

Adding Alternatives Boosts Long-Term Retirement Spending

Several emerging trends in the marketplace may lead to more participants staying in DC plans post-retirement in the future, including:

- Potential regulations redefining fiduciary roles and responsibilities, though the proposed rules remain in a state of flux
- Plan sponsor focus on retirement readiness
- Benefits of maintaining scale and institutional buying power

As such, long-term retirement spending metrics were tested to assess how well the alternative glide path constructions support retirement spending relative to the baseline glide path.

We utilized inflation-adjusted spending rules to assess the probability of asset depletion over longer-term retirement spending horizons. Specifically, we assume that at retirement, a participant takes his or her accumulated balance and spends a certain percentage in the first year. Each subsequent year, that amount is increased for realized inflation so the participant's retirement spending profile assumes constant spending in real (inflation-adjusted) terms.

A typical retirement spending heuristic is a 4% spending rule, which was reviewed along with a more aggressive 5% spending rule. In each of these scenarios, the spending amount plus inflation serves as a hurdle rate for the investments to avoid erosion of the principal balance over time. The objective is to support lifetime retirement spending, so some erosion of principal over time is acceptable as long as assets remain positive.

When reviewing the likelihood of retirement success, we note the diversified glide path outcomes are improved over any of the alternative asset classes used in isolation. As shown in Exhibit 12, on the following page, the single alternative asset class scenario that offered the best long-term results was hedge funds, though each alternative in isolation offered improvements over the

Probability of having positive assets under various spending levels and time horizons in retirement						
	Number of years after retirement	Baseline	With private equity	Wth real estate	With hedge funds	Diversified glide path
4% spending	15 years	100%	100%	100%	100%	100%
	20 years	99%	99%	99%	99%	99%
	25 years	92%	93%	93%	95%	96%
	30 years	80%	82%	81%	86%	89%
5% spending	15 years	99%	100%	100%	100%	100%
	20 years	89%	90%	90%	93%	94%
	25 years	66%	68%	67%	73%	78%
	30 years	45%	47%	46%	53%	60%

Exhibit 12

baseline. At a 4% spending level, all glide paths offered high probabilities of success over shorter time horizons, but over longer time horizons the diversified glide path offered probabilities of success between 4% and 9% better than the baseline. With a more aggressive 5% spending rate, the diversified glide path offers a 5% higher probability of success than the baseline over a relatively short 20-year retirement spending horizon. Over longer-term 25- and 30-year horizons, the diversified glide path outperforms by 12% and 15% respectively.

The diversified glide path performed well relative to the baseline over long-term retirement spending horizons, but DC plans support broad populations with varying objectives, so one might ask how participants who roll their money out of the plan may be impacted. As such, sponsors will want to review not only long-term success metrics but also shorter-term metrics given that certain participants will withdraw their full balances from the plan at or shortly after the point of retirement.

Adding Alternatives Can Mitigate Short-Term Risks Near Retirement

As we discussed previously, TDFs are designed based on assumptions about participant behavior, typically assuming participants will remain invested post-retirement (particularly for "through" glide paths, which continue to de-risk post-retirement). In reality, many participants do not remain in the DC plan post-retirement, either rolling over to an outside account or cashing out.

Our goal in this section is to determine how a custom TDF allocation and glide path that includes alternative investments needs to be adjusted to reflect this reality. To assess the magnitude of these risks we examine several metrics, including expected and downside returns at and through retirement, the probability and magnitude of real return shocks (i.e., loss of a participant's purchasing power) at retirement, and the likelihood of multiple years of poor investment results approaching retirement. We look at the impact of adding each alternative asset class in isolation and in combination. We note that the diversified glide path utilizes all these asset classes strategically in an attempt to increase portfolio efficiency at a comparable risk level, specifically, by earning more return for each unit of risk taken.

At retirement as shown in Exhibit 13 on the next page, the baseline glide path offers a projected return of approximately 5.1% with downside (5th percentile) results of –7.9%. The glide path continues to de-risk so that by age 75 the portfolio offers a projected return of 4.7% and a 5th percentile return of –6.2%. While the projected case provides reasonable growth, the downside scenarios represent material shocks to participant portfolios as participants are about to transition into retirement. The challenge in mitigating these downside risks stems from the multiple objectives of target date users.

One straightforward way to mitigate downside risk is to shift more equities into fixed income, though that approach would materially lower expected returns and adversely impact participants who intended to utilize the funds as a source for income throughout retirement. Additionally, shifting from equities to core fixed income lessens equity risk but increases other risks such as interest rate and inflation. Instead, participants may be better off by further diversifying their portfolios.

The diversified glide path aims to increase portfolio efficiency at a comparable risk level. As shown in Exhibit 13, the diversified implementation offers the highest Sharpe ratio, or expected return per unit of risk. With the objective of creating a portfolio of similar risk to the baseline, we looked at both the volatility of returns and the worst-case scenario, which is defined as a 5th percentile result. At retirement, the expected return of the diversified portfolio is projected 1.0% higher than the baseline, and while volatility (standard deviation) is 0.3% higher, the worst-case outcome, which is arguably a more meaningful risk measure for participants, is improved by 0.4%. Ten years after retirement, the diversified portfolio provides a materially lower risk level (worst case of –5.3% versus –6.2%) while still providing an additional 0.6% of projected return relative to the baseline.

The main takeaway is that there are several risk and return drivers in the marketplace and most TDFs offered today are overly

At Retirement (age 65)	Projected return	Volatility	Sharpe ratio	5th percentile "bad scenario" single-year return
Baseline	5.1%	8.0%	0.28	-7.9%
With private equity	5.3%	7.9%	0.31	-7.7%
With real estate	5.2%	7.8%	0.29	-7.6%
With hedge funds	5.5%	7.7%	0.33	-7.0%
Diversified glide path	6.1%	8.3%	0.38	-7.5%
10 years after retirement (age 75)				
Baseline	4.7%	6.7%	0.27	-6.2%
With private equity	4.7%	6.7%	0.27	-6.2%
With real estate	4.7%	6.6%	0.28	-6.1%
With hedge funds	5.1%	6.5%	0.33	-5.6%
Diversified glide path	5.3%	6.5%	0.37	-5.3%

Exhibit 13: Increased Efficiency Through Diversified Implementation Leads to Potential for Both Higher Expected Returns and Lower Downside Risk

exposed to equity risk as a primary driver, with interest rate and inflation as secondary factors. Diversifying asset exposures and broadening the investment opportunity set allows access to alternate return drivers (e.g., skill, illiquidity, credit) and provides benefits in scenarios where markets are stressed.

Given the transition into retirement and the spending of accumulated savings, participants are also concerned with inflation risk, or the ability of a portfolio to protect against the erosion of real (inflation-adjusted) purchasing power. If a participant's portfolio increases by 3% but costs increase by 6%, he or she has lost value on a real basis. TDFs today often utilize Treasury inflation-protected securities to manage this risk. TIPS are bonds that are contractually set to adjust for realized inflation. Given this low-risk inflation "insurance," TIPS also tend to come with the "cost" of lower expected portfolio returns relative to other assets that may have a positive relationship with inflation (e.g., the inflation pass-through from real estate investments).

As such, we review whether TDFs utilizing alternative assets can also help protect against inflation risk while maintaining higher expected returns.

To help assess this risk in the context of participants who may be leaving the plan, we looked at real return shocks at retirement. We want to understand the frequency and magnitude of the drawdown relative to inflation (which again is a hurdle rate that retirees care about greatly) if a participant were to experience a market shock right before he or she retired. Our baseline glide path has a 4.9% probability of losing 10% or more on a real basis the year of retirement, or about a one-in-20 chance. As shown in Exhibit 14, inclusion of private equity, real estate and hedge funds modestly mitigates inflation risks for participants at the point of retirement. Given the construction of the diversified glide path to target a similar risk level to the baseline at retirement, we see that the probabilities of large real-return shocks are comparable, but the probabilities of modest negative real returns are materially lower.

Probability of real return below x% the year prior to retirement			
	-10%	-5%	0%
Baseline	4.9%	13.2%	33.2%
With private equity	4.8%	12.3%	31.7%
With real estate	4.7%	12.7%	32.8%
With hedge funds	4.3%	11.1%	30.4%
Diversified glide path	4.6%	11.0%	28.1%

Exhibit 14

Probability of real return below x% for the three years prior to retirement		
	-10%	-5%
Baseline	0.9%	5.0%
With private equity	0.7%	4.3%
With real estate	0.6%	4.0%
With hedge funds	0.5%	3.5%
Diversified glide path	0.9%	4.3%

Exhibit 15

Finally, we reviewed the probability of sustained negative returns as retirement approaches. We analyzed the probability of negative three-year annualized returns prior to retirement for different thresholds and compared how our alternate glide paths fared as illustrated in Exhibit 15.

The probability of our baseline glide path experiencing average returns of –5% or worse per year for the three years preceding retirement is 5.0%. That means there is about a one-in-20 chance that a participant's portfolio loses more than 15% over the three years before he or she is set to retire. There is also just under a 1% chance (0.9%) that the participant loses 10% or more per year (30% or more cumulative) as he or she approaches retirement, a significant outcome that puts the participant's retirement readiness at risk. The diversified glide path lowers the risk of losing 5% or more per year by 0.7% with the probability of losing 10% or more per year being comparable to the baseline.

Including Alternatives in TDFs: Challenges and Solutions

If alternative assets can make such an important difference in retirement income outcomes and are regularly used in other investment programs today, such as DB plans, why are they not often seen in TDFs today?

While progress has been made, DC investment operations and oversight have not yet matured to the level needed to rival those of DB plans. This could be attributable to the DC plan's historical role as a supplemental savings vehicle in which participants must make more of their own investment decisions. In addition, plan sponsors may be hesitant to implement changes to their programs given the higher perceived fiduciary risks and concerns about possible litigation. The legal obligations of plan fiduciaries, such as the prudent selection of investment options or a reasonable level of fees, have been the subject of a significant number of lawsuits in recent years. However, such fiduciary obligations can be managed through a careful and prudent evaluation process focused on enhancing potential outcomes for participants. This includes addressing any concerns, such as liquidity and pricing, benchmarking, fees and governance, related to incorporating alternative investments into TDFs.

Liquidity, Rebalancing and Cash Flow Management

Liquidity management within a TDF is essential as the participant cash flows have variability though are generally predictable. The key question is whether the level of illiquidity accessed within a TDF is manageable especially near retirement where participant cash flows are less predictable. As illustrated in Exhibit 16 on the following page, the diversified glide path has over 70% expected short-term liquidity in both normal and stressed scenarios. Quarterly liquidity is materially higher in a normal market (approximately 95%) while falling to approximately 81% in a stressed environment. Still, under both scenarios material liquidity remains within the fund structure, and even in a stressed environment, 95% of the assets are expected to be liquid within two years.

Sponsors may have also heard of the availability of liquid alternative strategies and wondered whether these may mitigate the illiquidity risk when including alternatives in a TDF. A liquid alternatives portfolio is a combination of hedge funds and/or alternative betas. Most hedge fund and alternative beta strategies offer monthly or quarterly liquidity, which is more than sufficient to be categorized as liquid for the average institutional investor, especially compared with many private market strategies. Therefore, while we still acknowledge that liquidity needs to be managed within a TDF utilizing alternatives, as Exhibit 16 shows, a diversified TDF is expected to have ample liquidity whether the hedge fund allocation is implemented through direct hedge fund investments or a combination of hedge funds and alternative betas.

Fees

The rise in DC plan lawsuits, in particular those challenging plan fees, has led many plan sponsors to maintain a myopic focus on fees leading to tremendous growth and fee compression in indexed products. A typical fee range for passive off-the-shelf TDFs for a large institutional plan was 10 bps to 15 bps about five years ago. Today, that fee range is closer to 5 bps to 10 bps.[17]

As an example of this recent trend in DC, in 2017 passive target date series attracted almost 95% of the $70 billion in estimated net flows to target date funds. This is a relatively recent phenomenon as active TDFs saw higher flows than passive for seven of the eight

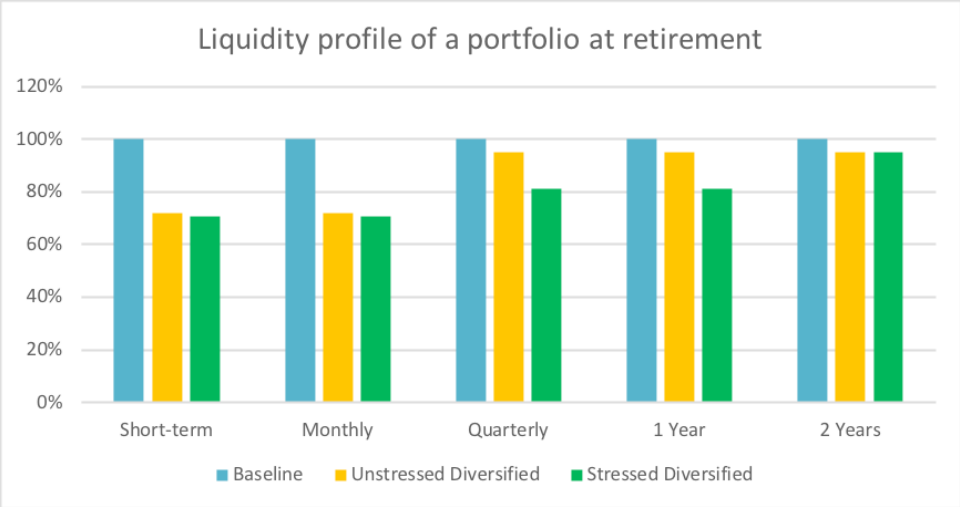

Exhibit 16: Liquidity Profile of Portfolio at Retirement

years between 2007 and 2014. In fact, in 2007 active saw inflows of more than $40 billion while passive saw only $16 billion in net flows, which represents a strong reversal from recent history.[18]

To include the potential benefits of alternatives in TDFs, plan sponsors need to be comfortable increasing total fund fees, which can be accomplished through a prudent process focused on enhancing potential outcomes for participants. The fee compression in TDFs has come at the expense of the potential increased returns, lower volatility and portfolio efficiency alternatives could provide. Recall that a participant spending his or her career invested in the diversified glide path is expected to have 17% more ($9,200) per year in annual income per $100,000 of pre-retirement income compared with the baseline and 11% ($2,300) more per year in annual income in a bad economic scenario.

There is no fiduciary requirement that sponsors implement the lowest cost option available, and it is not particularly controversial to state that participant outcomes are improved as long as the net-of-fee value proposition is positive. One way to manage the headline fee consideration is to engage in a formal fee budgeting process. This process effectively involves determining a reasonable all-in fee target and then building an efficient portfolio within those fee constraints. For example, as of December 31, 2017, the median institutional active target date fee was just under 50 bps.[19] If sponsors set a similar fee budget, they can determine how best to add value through the inclusion of diversifying strategies with an all-in fee cap of 50 bps or less. As opposed to primarily using the fee budget on more expensive active management, which is often what off-the-shelf active TDF providers focus on, sponsors can index more efficient asset classes and use those savings to fund alternative strategies that provide unique exposures and active management in less efficient asset classes.

Fund Pricing

Determining daily pricing is also a concern as many alternative strategies do not price daily. A price needs to be established to allow participants to trade daily. Pricing estimates can be established for alternative strategies without a public mark using market proxies, which can help smooth out the potential price jumps each time an underlying fund valuation is updated. Having a diligent pricing process is paramount to having faith in the program's implementation and ensuring that all participants are treated fairly.

Benchmarking

Public indices are available that may serve as benchmarks, but the challenge with these is that the asset allocations are often markedly different from the sponsor's; therefore, the strategies run at different risk levels. Similar to the analysis in this paper, reviewing the performance of the TDFs versus a reference glide path of market exposures with a comparable target risk level provides a basis for an evaluation of the TDFs' implementation efficacy and should be judged accordingly. Each portfolio underlying the TDFs may be benchmarked to an appropriate blended reference portfolio to understand how the funds have performed from a return, risk and risk-adjusted return standpoint. Additionally, the entire reference glide path may be used to periodically assess the strategic positioning and expectations for the funds.

Governance and Oversight

Throughout this paper we have mentioned the need for increased governance and oversight to implement a best-in-class alternatives program, so it is worth spending some time discussing the various implementation models. First, it's important to choose an implementation model that provides:

- Fund selection, including sourcing and diligence of funds backed by written recommendations
- Customized portfolio construction, including allocation sizes and investment guidelines
- Quarterly and annual reporting providing detailed performance and risk attributions as well as in-depth qualitative research on each manager
- Authority to direct custodian and managers on intra-trust asset transfers and transfers out of trust to fund mandates and pay expenses

In house	Co-sourced/outsourced
Sponsor had the ability to retain internal knowledge	Firms with a global scale leveraged across all clients
Internal objectives can be adhered to more closely because the internal team works directly with the investment committee	Additional support from asset class specialist teams - support with top-down views and portfolio construction philosophies
An internal team allows for more control over the portfolio	Shared fiduciary responsibility under the discretionary outsourced management relationship
	Dedicated operational due diligence team to evaluate non-investment risks
	Potential to access a more mature portfolio, which may lessen some of the early-stage return issues with some private investments

Exhibit 17

ERISA does not apply a higher standard of care for sponsors utilizing alternatives; rather, the increased governance is a function of the complexity of the asset classes. For example, sponsors utilizing alternatives should perform operational due diligence on top of their investment due diligence. This includes steps such as reviewing various due diligence documentation (e.g., offering memorandum, limited partnership agreements or articles of association, or audited financial statements), onsite discussions with key operational staff, creation of operational due diligence reports and manager ratings, and ongoing monitoring.

The two main methods for achieving this oversight are in-house and cosourced/outsourced models. Each has its benefits and considerations (see Exhibit 17).

It is important to acknowledge the challenges above, but we feel strongly that these challenges can be effectively managed to allow plan sponsors to take steps toward enhancing potential retirement outcomes for their population base. However, given the concerns about fiduciary risks and litigation, many plan sponsors may need additional guidance from policymakers to encourage such innovation.

Conclusion

It is important to emphasize why improving DC retirement readiness is of such critical importance in the current market environment. Today, U.S. workers are primarily relying on DC plans to serve as the primary retirement vehicles for their retirements — a purpose for which they were never intended.

In order to improve retirement income outcomes, plan sponsors must pull all of the levers at their disposal across their organizations. While a number of enhancements have been made with investment vehicles (e.g., TDFs, institutionally priced vehicles), plan design (e.g., auto-enrollment, auto-escalation, improved employer match structures) and communications (e.g., administrator technology, wellness platforms), DC plans still lag behind other large investment pools in the use of alternative asset classes. There is a reason why alternative assets are used more often in other investment pools: They can improve investment efficiency and the net-of-fee value proposition.

Given this realization, we tested the efficacy of adding three main asset categories — private equity, real estate and hedge funds — to TDFs given the stability and wide utilization of TDFs within DC plans. While each was found to provide benefits to participant outcomes, consistent with the objectives and risk/reward profiles of each asset category, we also found that:

- Private equity provides access to higher risk/reward assets through a skill-based implementation, which is balanced by the high diversification benefits in core real estate.
- Hedge funds provide exposure to manager skill as well as downside protection, with the added benefit of having low correlations with other asset classes due to the flexibility afforded to hedge fund managers.
- The combination of all these categories in a diversified portfolio provided improved results relative to the categories in isolation due to the synergies among the alternative asset categories.

The diversified implementation improved accumulation metrics, long-term retirement spending metrics, short-term risk and reward metrics, and asset-only metrics as summarized in Exhibit 18 on the following page.

We believe the widespread adoption of DC plans over time, along with the increased prevalence of TDFs, provides an opportunity for DC plan sponsors to enhance outcomes for their participants by including alternative investments. When DB plans were more prevalent there was not as strong a need to consider the added value generated by the use of alternatives in DC plans.

Because DC plans have become much more common, we must look at ways to improve the performance of investments. But this also requires addressing operational challenges, including the need for daily liquidity and daily pricing, to encourage wider adoption by sponsors. These challenges are now being addressed by alternative investment managers, and improvements in DC service provider capabilities can be seen today in the prevalence of custom funds in DC platforms.

In Willis Towers Watson's 2017 Defined Contribution Plan Sponsor Survey, 66% of sponsors with over $5 billion in assets

	Baseline	Diversified glide path
Expected retirement income	$53,000	$62,200
"Bad scenario" retirement income	$21,200	$23,500
Probability of positive assets after 30 years of spending at 4%, adjusted for inflation	80%	89%
Probability of positive assets after 30 years of spending at 5%, adjusted for inflation	45%	60%
Age 65 expected return	5.1%	6.1%
Age 65 "bad scenario" single-year return	-7.9%	-7.5%
Age 75 expected return	4.7%	5.3%
Age 75% "bad scenario" single-year return	-6.2%	-5.3%
Probability of one year inflation adjusted return <5%	13.2%	11.0%
Probablity of one-year inflation adjusted return <10%	4.9%	4.6%
Probability of three-year annualized return <5%	5.0%	4.3%
Probablitiy of three-year annualized return <10%	0.9%	0.9%

Exhibit 18: Summary Showing Improvements from Utilizing Alternatives in TDFs.

responded that they are utilizing custom white label funds, which represent custom fund structures utilized as either TDF building blocks or as standalone core investment options. With the increasing prevalence of these structures, DC service providers now have the experience and capabilities necessary to manage the operational issues (liquidity, rebalancing and cash flow management) directly through the fund structure.

Policymakers should consider these findings about the inclusion of alternative asset classes in DC plans and specifically through target date structures. Even absent any additional action by policymakers, plan sponsors with an interest in implementing portfolios with alternative asset classes can work with their advisors, custodians and recordkeepers to implement solutions that can potentially enhance participant outcomes for a more secure retirement.

Appendix

With the exception of private equity and hedge funds, the asset class assumptions above assume net-of-fee performance for large institutional investors implementing passively. For strategies where passive implementation is not possible, assumptions represent median results.

Active management premiums were included for private equity and hedge fund investments as these asset classes are ideally implemented through high-conviction, skilled, active managers, and the spread between best-performing and average managers is large. The assumptions were sourced from Willis Towers Watson's Portfolio Management Group based on its forward-looking views and corroborated by market data.

- According to Preqin data for all private equity funds, the average annual spread between first quartile and median managers for the 10 years from 2005 to 2014 was 6.1%.
- According to a PIMCO Hedge Fund report from June 2017, sourcing seven years of data (through 2016) from Eurekahedge and Bloomberg, the spread between 75th percentile and median hedge fund returns was 3.5%.

	First-year arithmetic mean	10th-year arithmetic mean	10-year geometric returns	Annual standard deviation
Global equities - unhedged	7.3	8.9	6.6	18.3
REITs	6.0	7.6	5.7	15.9
Commodities	3.7	5.3	3.7	14.9
Private equity	12.0	13.6	9.7	25.4
Real estate	4.7	6.3	5.2	9.8
Hedge funds	6.4	8.0	6.9	9.9
High yeild	2.4	5.4	3.8	10.0
Emerging market debt	1.0	5.1	3.1	9.5
Bank loans	3.6	5.2	4.3	7.9
Infrastructure	6.2	7.7	5.8	17.0
Aggregate bonds	0.8	3.9	2.6	4.2
TIPS	1.5	3.9	2.9	5.7
Cash	1.9	3.5	2.9	2.6

Endnotes

1. 100 basis points = 1%.
2. Alicia H. Munnell, Jean-Pierre Aubry, and Caroline V. Crawford, "Investment Returns: Defined Benefit vs. Defined Contribution Plans," Center for Retirement Research at Boston College, 15-21 (December 2015).
3. Sandy Halim and Maaike van Bragt, "Defined Contribution Plans Have Come a Long Way!" CEM Benchmarking Inc. (February 2018).
4. Mercedes Aguirre and Brendan McFarland, "2016 Asset allocations in Fortune 1000 pension plans," *Willis Towers Watson Insider* (January 24, 2018).
5. National Association of State Retirement Administrators Website.
6. Statistics in bullets from Willis Towers Watson's 2017 Defined Contribution Plan Sponsor Survey.
7. Auto-enrolling involves automatically deferring a portion of an employee's income into the DC plan unless he or she opts out. The Pension Protection Act of 2006 provides safe harbor protection to employers that automatically enroll employees into DC plans.
8. Willis Towers Watson 2017 Defined Contribution Plan Sponsor Survey.
9. Based on information from Morningstar's 2018 Target-Date Fund Landscape Report.
10. Based on information from Vanguard's How America Saves 2017 report.
11. Off-the-shelf products are those that are designed and pre-packaged by asset managers for broad usage by many plan sponsors as opposed to a custom implementation where the glide path and portfolios are built to the objectives of one sponsor.
12. Sourced from Willis Towers Watson's target date research glide path survey, updated annually, which is constructed using information from asset managers. To the extent an investment manager/fund family has TDF products with different glide paths, multiple glide paths may be used. The target date fund families include Alliance Bernstein, American Century, American Funds, BlackRock, Charles Schwab, Fidelity, JPMorgan, John Hancock, Mellon Capital, MFS, Northern Trust, PIMCO, Principal, Russell, SSgA, T. Rowe Price, TIAA, Vanguard, Voya, Wellington, and Wells Fargo.
13. Census data: Income and Earnings Summary Measures by Selected Characteristics: 2015 and 2016.
14. Based on information from Vanguard's How America Saves 2017 report based on Vanguard 2016 defined contribution plan data.
15. Based on data from Vanguard's How America Saves 2017 report based on Vanguard 2016 defined contribution plan data as well as the 59th Annual PSCA Survey of Profit Sharing and 401(k) Plans.
16. Alternative beta are risk premia often accessed through hedge fund structures with a systematic process to capture the premia (e.g., reinsurance, merger arbitrage, volatility and momentum).
17. Based on Willis Towers Watson research findings.
18. Based on information from Morningstar's 2017 and 2018 Target-Date Fund Landscape reports.
19. Fee data sourced from eVestment Alliance analytics services.

Authors' Bio

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Angela is a Research Professor and the Executive Director of the Center for Rertirement Initiateives. She works closely with government, industry and other key stakeholders interested in addressing the private sector workforce coverage gap and the future of defined contribution retirement savings plans. Angela is relied upon for her insights and opinions on issues related to retirement security and savings, including options for plan design and related legal and regulatory considerations, appearing in the *Wall Street Journal, New York Times, Pensions & Investments, MarketWatch,* and many other major news outlets. She serves as a member of the Expert Advisory Committee of the World Economic Forum's Retirement Investment Systems Reform Project and is a fellow of National Academy of Public Administration.

During her career, Ms. Antonelli also has held senior positions in government, public sector consulting, and financial services. She has written dozens of articles and testified several times before Congress on economic regulatory and government management issues.

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David's responsibilities include assisting institutional investors with asset/liability management, asset allocation, manager structure, investment manager research and selection, and ongoing manager due diligence. In addition, David leads Willis Towers Watson research and thought leadership in defined contribution investment strategy as Chair of the DC Strategy, Target Date Funds and Managed Account Area of Specialized Knowledge (ASK) teams.

Prior to joining the Investment line of business, David worked as an actuary where he assisted plan sponsors of benefit programs with plan design, valuation and administration.

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Narrowing the Return Gap: 10 Steps in the Right Direction

Adam Berger
Wellington Management

Gauging the Return Gap

In working with public pensions, we have seen return targets come down over the last 15 years, but only modestly. With large US plans, for example, the current average is still nearly 7.1%, versus 8% a decade ago. Return targets of corporate plans, endowments, foundations, and financial institutions have also declined somewhat, but they still pose a high hurdle when compared with capital market return expectations. Exhibit 1, on the next page, draws on data from six major investment consultants. On average, global equities are expected to provide a return of just under 7% and diversified, high-quality fixed income a return of just over 3%. Using those averages, a 60% equity/40% fixed income portfolio would provide a return of less than 5.5%— a far cry from the returns most investors need.

Even if we replace some core equity and fixed income with assets that have higher expected returns, including private equity, high-yield bonds, and emerging market debt, a 60%/40% "plus" portfolio (bottom half of Exhibit 1, next page) would still have an expected return below 6%.

The low return expectations can be chalked up to several factors, the most underappreciated of which may be the low risk-free rate of return. Prior to the global financial crisis, the risk-free rate in the US was 4% – 5%, which meant institutions were seeking to add 3% – 4% by holding risky assets. Today, of course, the risk-free rate is lower. Even if we use the 10-year US Treasury bond as the risk-free asset (with a yield of roughly 3% at the end of November 2018), investors are still looking to their risk exposures to generate excess returns of 4% – 5% or more above the

Capital market expectations are low

	Return expectations (%)	
	Average	Median
Global equities	6.8	6.8
Core fixed income	3.1	3.0
Implied 60/40 portfolio	**5.3**	**5.3**
Private equity	7.7	7.7
High yield	4.5	4.8
Emerging market debt	4.7	4.7
Implied 60/40 "plus" portfolio	**5.6**	**5.6**

Average return expectations were sourced from six major investment consultants. Available estimates for each asset class were averaged. 60/40 portfolio: 60% global equities/40% core fixed income. 60/40 "plus" portfolio: 45% global equities/15% private equity/30% core fixed income/5% emerging market debt/5% high yield bond. | Source: Wellington Management | Data as of December 2017; most current data available.

Exhibit 1

risk-free rate. Also contributing to the muted return outlook are high equity valuations, the expected growth headwind of aging populations in many developed and emerging markets, and the lower returns being provided by alternatives, as many formerly "alternative" strategies become more mainstream (and therefore more crowded).

Where Do You Go From Here?

Confronted with this gap between return targets and return expectations, institutions might consider two very different paths.

Do nothing — This idea is not as crazy as it may sound. The capital market expectations (CMEs) we highlighted in Exhibit 1 generally have a horizon of 10 years, but institutions' return targets often have a horizon of 30 years or more. Opting not to make significant portfolio changes and essentially waiting out a period of low returns would avoid the risk of a bad decision or an overreaction to the current market environment. On the other hand, it could mean digging an even deeper hole, especially if the low return regime lasts substantially longer than expected. Our research suggests that this approach may work for pension plans that are well funded and have minimal net cash outflows (plan contributions minus benefits paid). But for most plans, even a strong run of asset returns in the future may not compensate for the damage done by 5 – 10 years of underperformance.

Ramp up risk — At the other extreme, institutions might view Exhibit 1 as an argument for substantially increasing risk in pursuit of return targets. That typically means reducing exposure to bonds or other lower-risk assets and adding to stocks and other higher-risk assets. The problem is that such a shift also entails more exposure to drawdown risk — and at a time when there are valid concerns about equity valuations. In addition, the required changes in asset allocation could be dramatic. Let's assume an institution has a 7.5% return target and sets an expected return of 8% for global equities and 4% for core bonds. (These numbers have to be higher than the roughly 7% and 3% assumptions in Exhibit 1, or the task will be impossible.) Achieving a 7.5% return target would then require an allocation of 92% global equities and 8% core bonds (Exhibit 2). Historically, that mix would have experienced drawdowns with which many institutions would not be comfortable.

Boosting risk could mean bigger drawdowns

Assuming 1% alpha	
Global equities (%)	8
Core bonds (%)	4
Getting a 7.5% return with those assumptions	
Stock allocation (%)	92
Bond allocation (%)	8
Largest drawdown since 1926 (%)	-80
Largest drawdown in last 30 years (%)	-47

Average return expectations were sourced from six major investment consultants. Available estimates for each asset class were averaged. | Stocks: S&P 500; bonds: Jan 2014 – Dec 2017 Bloomberg Barclays US Govt Intm Bond, 1926 – 2013 Ibbotson US Intm Govt Bond. Portfolio rebalanced monthly. | There can be no assurance the performance objectives or characteristics will be met or maintained. Actual results may vary from the example provided. | Sources: Ibbotson, Datastream, Wellington Management | As of December 2017; most current data available.

Exhibit 2

A Third Path: 10 Stepping Stones

Is there another way to address the gap between asset class expectations and portfolio return targets? While many hope to "bridge" it in one go — a tall order, in our view — we propose a series of "stepping stones." While they each entail some measure of risk, we believe that in a world with no perfect answers, these incremental steps can help move portfolios in the right direction.

Get More Active in Equities

First, a caveat: Investors should generally be wary of asset managers overpromising on their ability to help solve return problems. That said, we think active equity approaches are appealing today. The medium-term outlook for traditional risk assets is below average. But the medium-term outlook for active risk may be at or even above average. Many active managers have underperformed in recent years, and active management has historically demonstrated some mean-reversion characteristics. What's more, the volume of assets that has flowed into passive or other index-like approaches means there is less capital chasing active management opportunities, potentially providing more scope for active managers to add value.

Investors seeking to use active risk in equities to boost returns should learn from past mistakes and take advantage of new approaches (Exhibit 3). They should look beyond the traditional "style box" to a broader range of active equity styles, including contrarian, momentum, and quality strategies, in order to build a more diversified stream of alpha sources with a higher risk-

adjusted return. We believe it's also important to avoid strategies with low active share and high turnover, sources of "friction" that we think have impeded active management's success over time. Finally, investors should seek to avoid the "hamster wheel" of hiring and firing managers, which often occurs when institutions hire managers in the wake of a period of very strong performance, setting themselves up to be disappointed when performance weakens and they move on to hire the next "hot" manager. One way to avoid the hamster wheel is to shy away from hiring managers with the strongest near-term track record, but it may be more realistic to create a structured and deliberate process that will foster patience — with a formerly high-performing manager who might struggle out of the gate, for example.

Active management lessons learned

- Look beyond the style box
- Pay more attention to active share and turnover
- Avoid the hamster wheel of hiring/firing

Exhibit 3

Find Cash-Flow Compounders

Getting more active in equities is about adding alpha to the lower expected equity returns we saw in Exhibit 1, but strategies we call "cash-flow compounders" try to sidestep those expected returns completely. Cash-flow compounders are equity strategies that seek to invest in companies with strong free cash flows relative to their market price. Assuming those cash flows are reasonably stable — and assuming company management deploys them effectively (whether via dividends, buybacks, capital investment, or prudent acquisitions) — then shareholders should reap long-term growth regardless of what happens in the broader market. In other words, the expected return from current and future cash flows may be higher than the expected return for the stock market as a whole.

Seek Upside by Limiting Downside

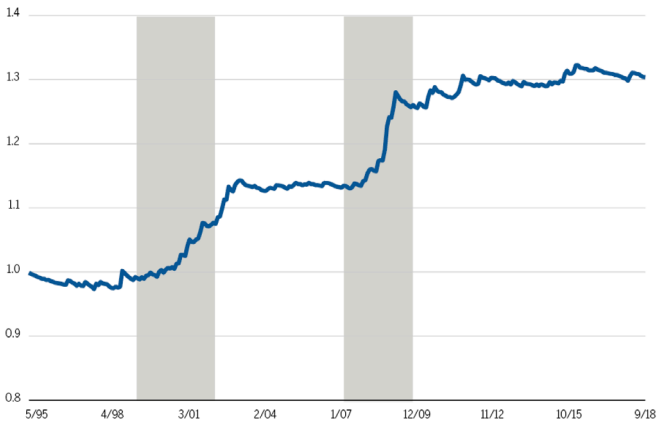
Investors sometimes overlook strategies that seek to add alpha by outperforming when markets struggle. Exhibit 4 illustrates a hypothetical strategy that captures 95% of the return of the S&P 500 in up months but only 85% in down months. Not surprisingly, the strategy adds value when the S&P 500 falls, including during bear markets (shaded areas). But it also holds its own in bull markets, when it might have been expected to struggle. Strategies that seek to limit downside in essence take advantage of the power of compounding. In an environment that is likely to be rocky, strategies with the potential to mitigate downside risk may help smooth the path to a target return.

Invest Thematically

Thematic investing is an unfamiliar approach for many investors, but it represents another way to truly break out of the style box and away from cap-weighted indexes. Thematic investments by their nature try to take advantage of secular trends — and, as a result, are often delinked from the global business cycle. Consequently, their returns — like those of the cash-flow compounders described earlier — are likely to be decoupled

The value of outperforming in down markets

Relative performance of 95% upside participation/85% downside participation strategy in bull (white chart background) and bear (shaded areas) markets vs the S&P 500



Source: Wellington Management | Period analyzed from January 1995 through 30 September 2018 based on monthly returns. The 95%/85% strategy is for illustrative purposes only, and is not representative of an actual account managed by Wellington Management. Hypothetical returns were calculated with monthly S&P 500 Index returns. Each positive monthly return was multiplied by 0.95 and each negative monthly return by 0.85. The resulting monthly return stream was then used to calculate hypothetical performance and characteristics for the 95%/85% strategy. | **PAST RESULTS ARE NOT NECESSARILY INDICATIVE OF FUTURE RESULTS.** This strategy is hypothetical and is not offered by Wellington Management.

Exhibit 4

from capital market expectations. Examples of themes investors are pursuing today include advances in biotechnology and development trends in emerging markets, such as the growth of the middle class.

Optimize Fixed Income Exposure

Fixed income is a substantial allocation in many portfolios, but in the current environment it is not carrying its weight with respect to return generation. Historically, bonds offered liquidity, income and protection against financial crises or deflation, as well as reasonable returns. Today, "core" fixed income may pursue the first two or three of these, but not the fourth, given current interest rate levels. Ultimately, portfolios anchored to the Bloomberg Barclays Aggregate Index may be limited in their potential for return generation (Exhibit 5, on the next page). And "core plus" strategies often have only modest allocations to higher-returning segments of fixed income.

We believe investors may be better served by separating the defensive exposures from the return-seeking exposures in a fixed income portfolio and optimizing each independently. The defensive component might include government bonds and perhaps high-quality investment-grade securities, and could take on more duration risk than the Barclays Aggregate. The return-seeking exposures could include opportunistic strategies that rotate across different credit sectors according to their attractiveness or absolute-return, relative-value strategies, which are sometimes overlooked by fixed income investors. Exhibit 5 shows the attractive current yields on two of the more return-oriented fixed income sectors, but return-focused strategies and managers can tap into an even wider opportunity set.

Enhance Alternatives with Portable Alpha

We argued earlier that investors should consider taking more active risk in equities. For many, this may be best pursued through a blend of long-only active managers, as we described. But for investors who own (or can construct) a portfolio of market-neutral alternative strategies, portable alpha may offer a more potent way to pursue active equity. (As a reminder, portable alpha combines cash investments in market-neutral absolute-return-seeking strategies with futures that replicate a market exposure, usually stocks or bonds.) Portable alpha in essence seeks to close the gap between capital market expectations and return targets by layering the benefits of absolute return on top of the passive return to a broad asset class. Historically, some managers struggled with first-generation implementations of portable alpha, but there are managers who have strong track records in this area and take a thoughtful approach to the integration of the absolute return and the beta.

Seek Illiquidity Premium Opportunities

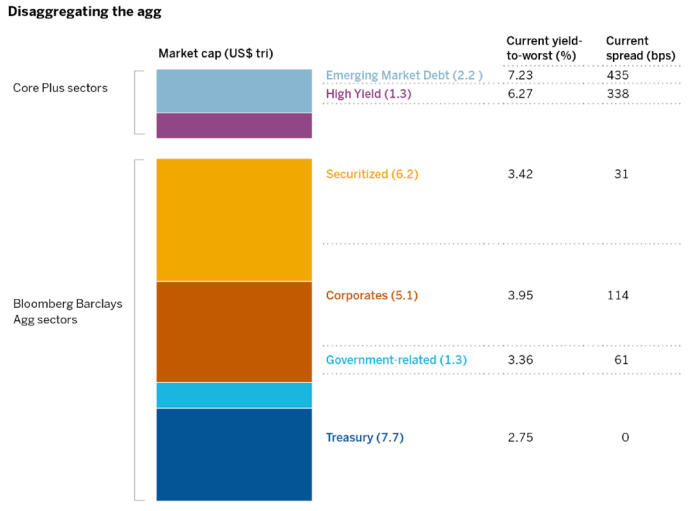
Investors seeking to hit their return targets should leave no stone unturned in pursuit of potential return sources, and that includes pursuing the benefits of an "illiquidity" premium. Currently, however, there is a lot of money on the sidelines in the private equity world, which may mean there is less of an illiquidity premium to be earned. (If too much capital chases the same risk premium, that premium may disappear, at least temporarily.) So, it's important to be thoughtful about exactly which illiquid assets may earn a premium over liquid assets. One area we think is interesting today is late-stage pre-IPO companies. In recent years, venture-capital-backed companies have been opting to stay private longer, a trend that is changing the composition of small-cap indexes (Exhibit 6). If companies are larger and more mature when they go public, then public market investors may be missing out on their early and often rapid growth. An investment in private late-stage companies might be thought of as a completion portfolio for a traditional small-cap allocation.

Dial Up Infrastructure Exposure

The characteristics of infrastructure investments align well with institutions' risk and return goals, as they potentially offer long-term returns that are steady (or even contractually guaranteed) and often paid out through regular distributions. However, we hear anecdotally that many asset owners who have allocated capital are waiting longer than expected for it to be called and put to work. In the meantime, there is an ample and largely untapped opportunity in publicly listed infrastructure investments, which we believe offer many of the same characteristics as private assets, as well as several advantages, including greater liquidity, the ability to be tactical in sector and geographic allocation, and the ability for managers to outperform by managing for total return in a market that is often focused on yield.

Find Ways To Be More Contrarian

Adopting a more contrarian mindset in portfolios is a potentially powerful way to enhance returns compared with broad market exposure. Restrained capital market expectations reflect the fact that the growth in intrinsic value offered by investments — the slope of the straight line in Exhibit 7, on the next page — has probably come down over time. But what happens to that line matters less for contrarian investors, who seek to buy at a point of pessimism and then sell when there's more exuberance, thereby tilting the slope of the line in their favor. There are several ways to bring a contrarian discipline to a portfolio: through asset allocation (buy "beaten up" asset classes), manager selection (allocate to strategies that have faced a recent headwind), or security selection (buy securities that engender apathy and avoid those that investors love).



Source: Bloomberg Barclays as of 31 August 2018

Exhibit 5

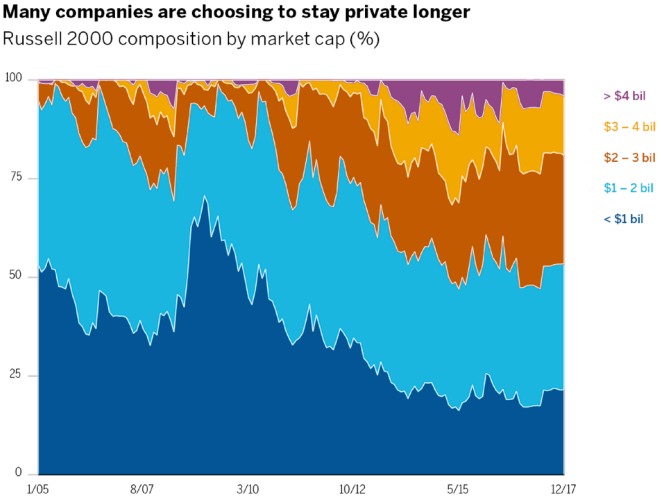


Chart data: 31 January 2005 – 31 December 2017; most current data available.

Sources: Russell Investments, Wellington Management

Exhibit 6

Consider "Core Alternatives"

Many investors are already using alternative investments to help them reach their objectives, but we believe there are opportunities to improve returns by building more efficient alternative portfolios. To help, we propose a core/satellite framework, particularly for hedge funds. The core in the structure — a class of strategies we call "core alternatives" — seeks to generate returns using the same drivers as hedge funds, including risk factors, security selection, macro tilts, and hedging. By implementing these drivers more simply, efficiently, and transparently, core alternatives may help investors free up time and capital to pursue "satellite" strategies that may be more niche-oriented, less liquid, and/or higher-fee. This is not a "one size fits all" framework. The sizing of the core and satellite allocations relative to each other will be a function of several factors, including the institution's risk and return objectives, manager relationships/access to the desired alternatives, and fee sensitivity.

One return driver of many core alternatives is exposure to alternative risk premia — market-neutral exposures to "risk factors," such as carry, trend, convergence, and equity-style premia, that have historically offered a positive return to investors willing to bear them. Investors concerned that traditional risk premia (compensation for taking traditional long-only market risk, as in equities) will offer lower returns in the current environment may benefit from shifting risk at the margin toward strategies that more intentionally target these alternative sources, which have historically provided diversification (relative to each other and the market) and less exposure to stock market drawdowns.

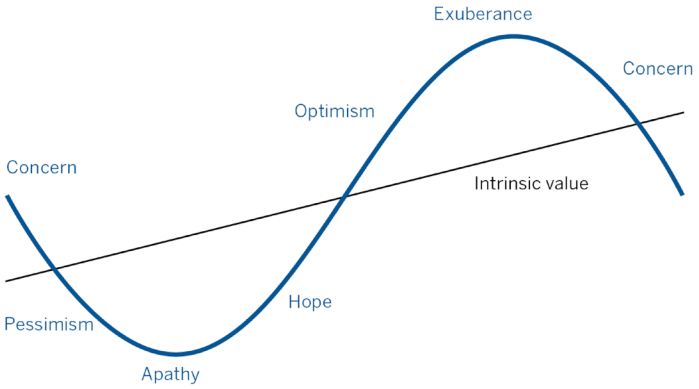
Core alternatives also include a family of strategies we call "8&8" portfolios, because their managers generally seek to generate total return of about 8% with a comparable level of volatility. These strategies are often multi-asset, and they tend to draw on a range of techniques (including several of the stepping stones noted above). They may, for example, balance long and short equity exposures; combine market beta, alternative beta and alpha with an overlay of risk management; or combine multiple hedge fund strategies across disciplines to create a portfolio with only modest beta to global equities.

Selecting Stepping Stones and Putting the Risks in Perspective

The beauty of the "stepping stones" approach is that there is no single predetermined path to implement them. Investors can seek to improve returns by choosing a subset of steps that are in sync with their investment beliefs and institutional history, and consistent with board priorities. Ideally, the steps should build on the existing expertise of the organization. Investors should choose steps that can be explained logically to constituents, and they should have enough conviction to avoid being pressured to shift out of them if they don't work immediately.

Exhibit 8 offers an illustration of how some of these stepping stones could be incorporated across a portfolio. In the equity allocation, the stepping stones might include a shift from passive to active strategies, an increased role for more defensive strategies, and the use of portable alpha. In the fixed income allocation, one might separate defensive exposures from return-seeking exposures and seek to optimize each — for example, by adding to credit strategies and absolute-return strategies. In the alternatives allocation, there might be a role for core alternatives, including strategies that pursue alternative beta, as well as an increased role for infrastructure exposure via publicly listed investments. And then across the portfolio broadly, one might look for opportunities to be more contrarian and to invest thematically.

A contrarian investor mindset



Source: Wellington Management

Exhibit 7

How to incorporate "stepping stones" into your portfolio

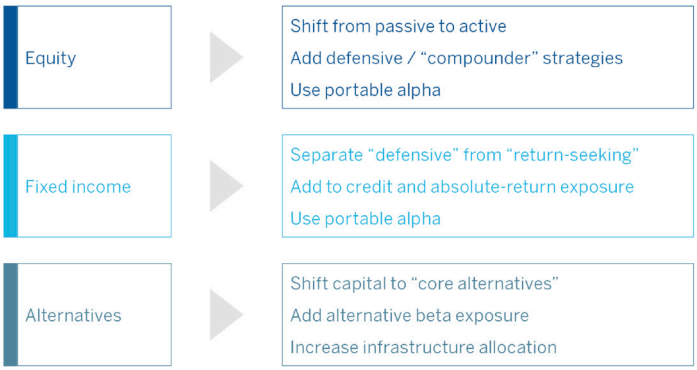


Exhibit 8

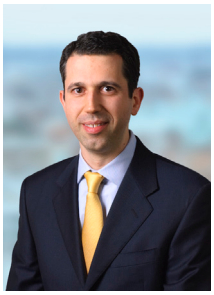
The overall approach will vary by investor. It may be to add more alpha from assets whose CMEs are too far below the investor's return targets; to shift from asset classes (or sub-asset classes) with lower CMEs to those with higher ones; or to sidestep the CMEs completely and pursue strategies that may provide returns that aren't closely linked to those of broader asset classes.

In applying these ideas, it's important to remember that some of the stepping stones may increase portfolio risk. For example, portable alpha strategies involve leverage and contrarian strategies may increase volatility. But we think the overall risk impact of these stepping stones on a diversified portfolio should be modest. Adding active risk is often diversifying to the beta in a portfolio, and different sources of active risk can be diversifying relative to each other.

Conclusion

The current market backdrop is without question a challenging one, and there's no quick fix and no single "bridge" that will get investors where they need to go. But there are effective steps that can be taken. The challenge for investors is choosing which to take and managing the process of implementation.

Author Bio



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Adam is a multi-asset strategist at Wellington Management. He develops research on capital market and asset allocation themes, advises clients on investment strategy and policy issues, and implements investment solutions for clients. Adam earned his M.B.A. from the University of Pennsylvania and his A.B. degree from Harvard College.

Tailoring Multi-asset Multi-factor Strategies

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Factor investing cuts through the traditional way of organizing an investor's asset allocation. But not every investor can simply overhaul their investment process and go directly for the magic bullet solution – especially if an allocation to traditional asset classes is already in place. So, how do multi-asset factors work in such a context?

Recent years have seen rapid development in the ability to diversify through factors in an attempt to construct more efficient and better risk-managed portfolios. In the process, it is obviously necessary to identify the most salient drivers of assets' risk and return. Thus, we developed a diversified risk parity strategy that maximizes diversification benefits across asset classes and style factors.[1] The ensuing top-down allocation combines traditional market premia associated with equity, duration and credit risk as well as style factor premia associated with carry, value, momentum or quality style investments.

Striving for Maximum Diversification in a Multi-asset Multi-factor World

Style factor investing has a long history in both academic research and quantitative equity investing. Yet the general notion of style factors to explain the cross-section of asset returns also extends to other asset classes: e.g., the phenomenon that recent winners outperform recent losers applies not only to equities, but is also pervasive for commodity, rates and FX investments.

Clustering Styles Across Asset Classes

While adding such style factor strategies can serve to advance a given portfolio's diversification, the flip side is that the quality of portfolio optimization suffers from increasing the size of the variance-covariance matrix. Aggregate factor analyses are designed

to overcome these shortcomings, but it is a challenge to create and organize the factors in the multi-asset space. Adopting a pure style factor view, it seems straightforward that single factor strategies that follow the same style should be aggregated across asset classes, rather than aggregating different styles within asset classes. For instance, an aggregate momentum style factor would be based on equity momentum, commodity momentum, rates momentum as well as FX momentum. Aggregate carry, value and quality factors are built in the same vein.[2]

To investigate the merits of integrating these four top-down style factors into a traditional asset allocation, we likewise aggregate three market risk factors for traditional asset classes. Following the method used for our previous analysis, we consider equity, duration and credit risk factors. The equity and bond factors derive from aggregating global equity and bond index futures. The credit risk factor is based on US investment grade and high yield investments.

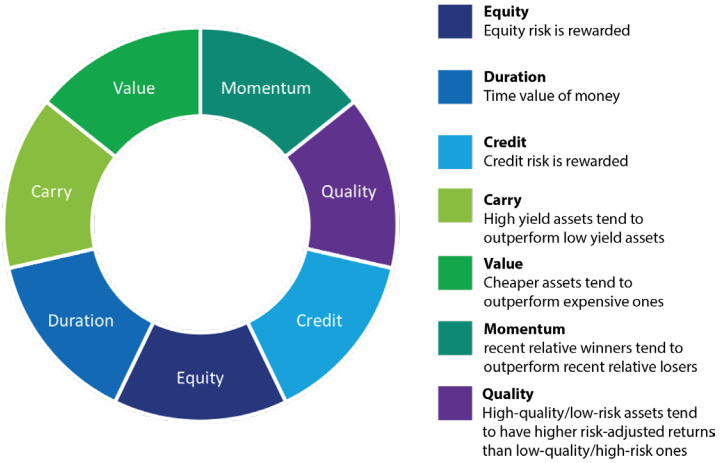


Exhibit 1: Diversified Risk Parity; Building Blocks and Stylized Risk Allocation
Source: Invesco, For Illustrative purposes only.

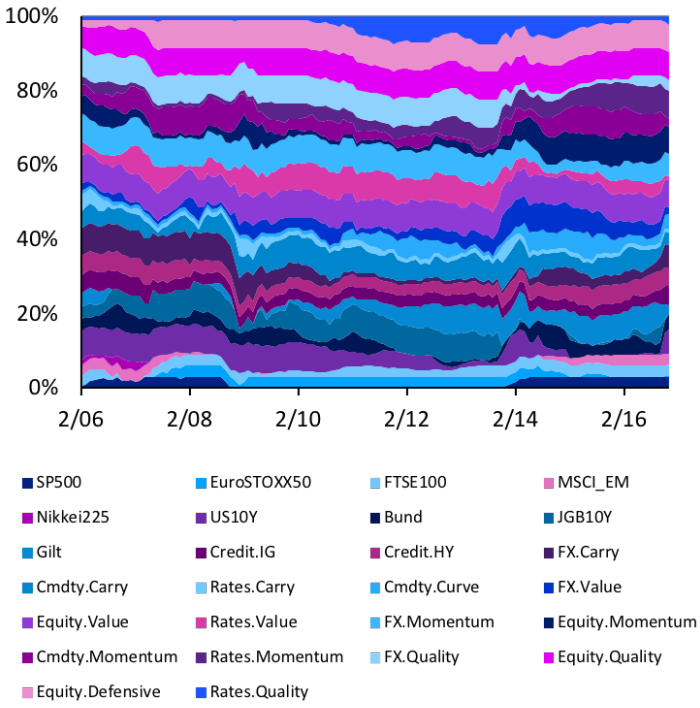
Diversified Risk Parity

A diversified portfolio allocation is best suited to ensuring balanced and effective harvesting of premia from market risk and style factors. Specifically, a diversified risk parity strategy (DRP strategy) maximizes portfolio diversification in a way that resonates with the intuition that 'a portfolio is well-diversified if it is not heavily exposed to individual shocks' (Meucci, 2009).[3] A DRP strategy incorporating these general building blocks would allocate equal risk budgets across asset classes and factors, as depicted in Exhibit 1, such that each aggregate asset class and style factor accounts for one-seventh of overall portfolio volatility.

Given this parsimonious structure, the DRP strategy can handle complex portfolios comprising many asset classes and factors without compromising the stability of the variance-covariance matrix.

Maximum Diversification in a Multi-asset Multi-factor World

To illustrate the strategy's characteristics, Exhibit 2 depicts weights and risk allocation for a DRP strategy subject to standard investment constraints, such as long-only and full investment constraints. Still, the corresponding risk allocation is fairly balanced across global asset class and style factors. On average, the risk profile corresponds to 6.44 effective bets[4] out of 7 (= 3 market + 4 style factors) that would constitute the unconstrained optimal solution.



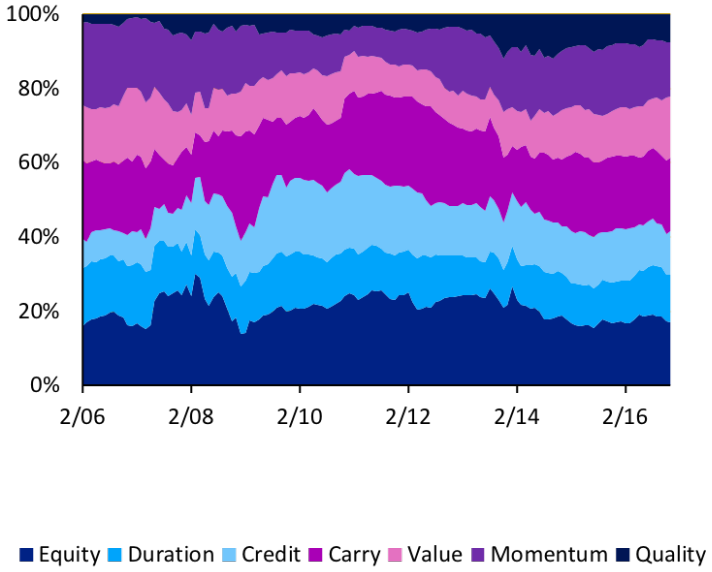


Exhibit 2: Diversified Risk Parity; Weights and Risk Allocation
Source: Bloomberg, Invesco, Goldman Sachs. Data period: January 31, 2006 to December 31, 2016

Thus, although DRP takes into account evolving market dynamics, its factor allocations will be far from over-fitting or over-reacting to markets. Below, we demonstrate how to integrate factor investing and the notion of DRP into the toolkit of a traditional asset allocator.

Monitoring and Managing Market and Style Factors

Despite the mounting evidence of style factors' relevance, the predominant allocation paradigm is centred around traditional asset classes. However, there will always be implicit factor tilts embedded in traditional asset allocations, even if style factors are not managed explicitly. Obviously, it would be more appealing to assume explicit control of these style factor tilts. Utilizing style factors in the risk and portfolio management of multi-asset solutions can be highly beneficial. At the very least, one can prevent unwanted exposure to factor risks that way. At best, one can optimize the overall risk profile along market and style factors to efficiently harvest the associated asset and factor premia.

Traditional Asset Allocation Through the Factor Investing Lens

To illustrate the relevance of style factors, we x-ray a traditional multi-asset allocation in terms of its global market and style factor exposures. In particular, we consider a client whose strategic asset allocation is one-third in global equities, one-third in global government bonds and one-third in corporate bonds.[5]

To flesh out the risk exposures of this allocation over time, we linearly map the returns R of the underlying 11 market assets and 15 style factors on the seven factors F:

$$R = B'F$$

where B is a 7 x 26 matrix containing the factor sensitivities. In turn, the variance-covariance-matrix Σ of returns R can be decomposed as:

$$\Sigma = B' \ \Sigma_F B + u$$

where Σ_F is the global factor variance-covariance-matrix and u captures the idiosyncratic variance.

Equipped with this linear risk model, we can decompose the systematic portfolio volatility of the above strategic asset allocation (see Exhibit 3). Notably, half of the portfolio's volatility is attributed to equity risk. Also, there is a strong exposure to pure credit risk, whereas duration risk adds only marginally to overall portfolio risk. Finally, there are notable implicit exposures towards the carry and quality style factors. On average, this risk profile corresponds to 3.61 effective bets over time. Thus, one is only partially exploiting the diversification spectrum available in the underlying multi-asset multi-factor universe. With 7 being the maximum number of effective bets, there is obviously room to further improve the risk allocation.

Tapping Factors for Multi-asset Multi-factor Management

In this section, we present alternative ways of embracing factor investing and the notion of diversified risk parity from the perspective of a traditional asset allocation.

Tail-hedging Using Style Factors

As a modest first step to allowing factor investing into the traditional asset allocator's toolkit, one might consider adding a style factor exposure in the pursuit of better risk management. In

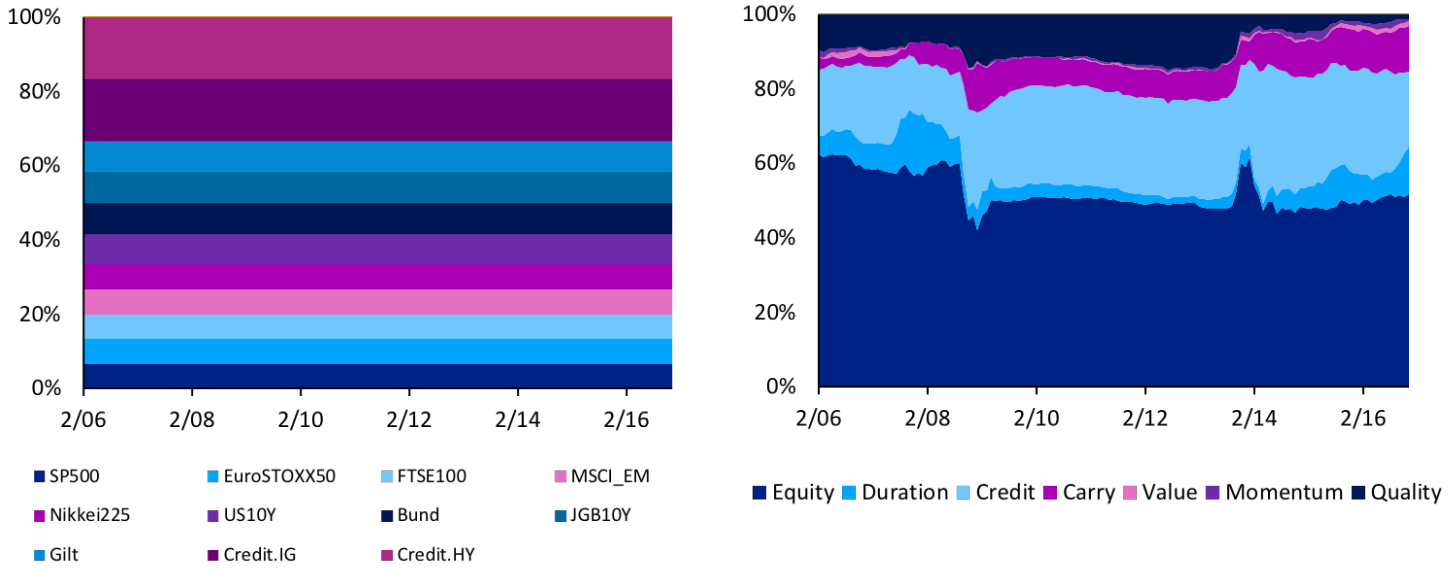


Exhibit 3: Traditional Asset Allocation Through the Factor Investing Lens
Source: Bloomberg, Invesco, Goldman Sachs. Data period: January 31, 2006 to December 31, 2016

this vein, we provide a portfolio optimizer with both traditional asset and factor returns. While we fix investments in traditional assets to equal the strategic asset allocation, we allocate style factor weights such that ex-ante portfolio risk is minimized. Thus, one could think of the additional factor allocation as a minimum-variance or tail hedge. From the first row in Exhibit 4, (on the next page) we learn that the quality factors in equity, rates and FX are particularly useful in hedging portfolio risk. In addition, equity and FX momentum help achieving the optimization objective.

Indeed, the corresponding strategy volatility (6.2%) is reduced relative to the benchmark volatility of the strategic asset allocation (7.1%), as set out in Exhibit 5. What's more, the devastating benchmark drawdown of 25.2% is reduced by more than 10 percentage points to -14.3% by including the tail hedge factor allocation. Obviously, this risk mitigation also increases risk-adjusted performance (as demonstrated by the Sharpe ratio of 1.30). However, in terms of diversification, the pick-up is rather modest: the average number of effective bets increases from 3.61 to 3.92. This marginal increase derives largely from the reduction in equity risk exposure vs. the pick-up in duration risk implied by the style factor allocation. While this observation makes sense from a pure tail-hedging perspective, we will investigate ways to achieve a more diversified risk allocation.

Factor Completion Based on Diversified Risk Parity

To more directly balance the overall portfolio's risk profile, we consider an alternative strategy that we label factor completion. Essentially, this strategy endeavours to integrate a factor portfolio that optimally completes the risk allocation of a given strategic benchmark asset allocation. To this end, we first extract implicit asset and factor return forecasts from the optimal diversified risk parity allocation. In an unconstrained portfolio optimization, these return forecasts would simply yield the DRP allocation. Given the benchmark allocation, we provide this diversified risk parity view to a mean-variance portfolio optimization in which the underlying strategic benchmark asset allocation is again fixed.

The second row of Exhibit 4 illustrates the corresponding weights and risk allocation. Now that we seek to balance risk and return based on the above view assumption, the overall allocation steps more strongly into a broad style factor completion portfolio. As a result, the risk allocation over time is considerably less concentrated in equity risk, yet there is a limit to equity risk reduction given the strategic benchmark allocation constraints. However, the diversification benefits of the factor completion solution are sizeable, as represented by 5.58 effective bets on average. These benefits arise from the fact that equity risk accounts for only a quarter of the risk budget, while the style factors carry, value and momentum play a more prominent role given their larger nominal weights (or leverage). While the strategy's volatility is on par with that of the benchmark strategy, we have succeeded in reducing the maximum drawdown relative to the tail hedge portfolio by a further 3 percentage points.

Pure Diversified Risk Parity

To effectively maximize portfolio diversification, we need to lift the investment constraints that have fixed the strategic benchmark allocation in the preceding examples. To still live up to the client's risk profile, we additionally need to lever the diversified risk parity allocation. As a result, the risk allocation exhibits reduced equity risk exposure at a total number of bets of 6.46 (see final row of Exhibit 4 and Exhibit 5, below). Note that this pure DRP approach would more than double the annualized return of the benchmark strategy. Given a single-digit drawdown of -8.6%, the pure DRP portfolio posts a highly attractive return to drawdown ratio of 1.39.

The presented framework naturally lends itself to exploiting tactical asset allocation signals while still embracing the merits of diversified risk parity. A future article will investigate the inclusion of trend signals, which allow investors to meaningfully operationalize the common trend style permeating many asset classes.

Conclusion

Style factors are salient drivers of returns for several asset classes. Traditional asset allocations tend to be minimally balanced across style factors and would benefit from explicit management of both asset and factor exposures. Based on a meaningful set of market and style factors, we have illustrated a reasonable allocation mechanism centred around a diversified risk parity view. The ultimate outcome of a diversified risk parity strategy is a highly sophisticated portfolio solution that benefits from better building blocks as well as technical advancements in portfolio construction. This article highlights the strengths and flexibility of this novel technique in creating multi-asset multi-factor portfolios that can serve various clients' needs.

Performance Statistics	Benchmark	Tail Hedge	Factor Completion	Pure DRP
Return p.a.	4.9%	9.3%	12.9%	12.0%
Volatility p.a.	7.1%	6.2%	7.3%	7.1%
Sharpe ratio	0.56	1.30	1.57	1.49
Maximum drawdown	-25.2%	-14.3%	-11.4%	-8.6%
Calmar ratio	0.19	0.65	1.13	1.39
Number of bets	3.61	3.92	5.58	6.46
Turnover	0.0%	8.6%	19.8%	28.3%

Exhibit 5: From Traditional Multi-Asset to Multi-Asset Multi-Factor Management
Source: Bloomberg, Invesco, Goldman Sachs. Data period: January 31, 2006 to December 31, 2016

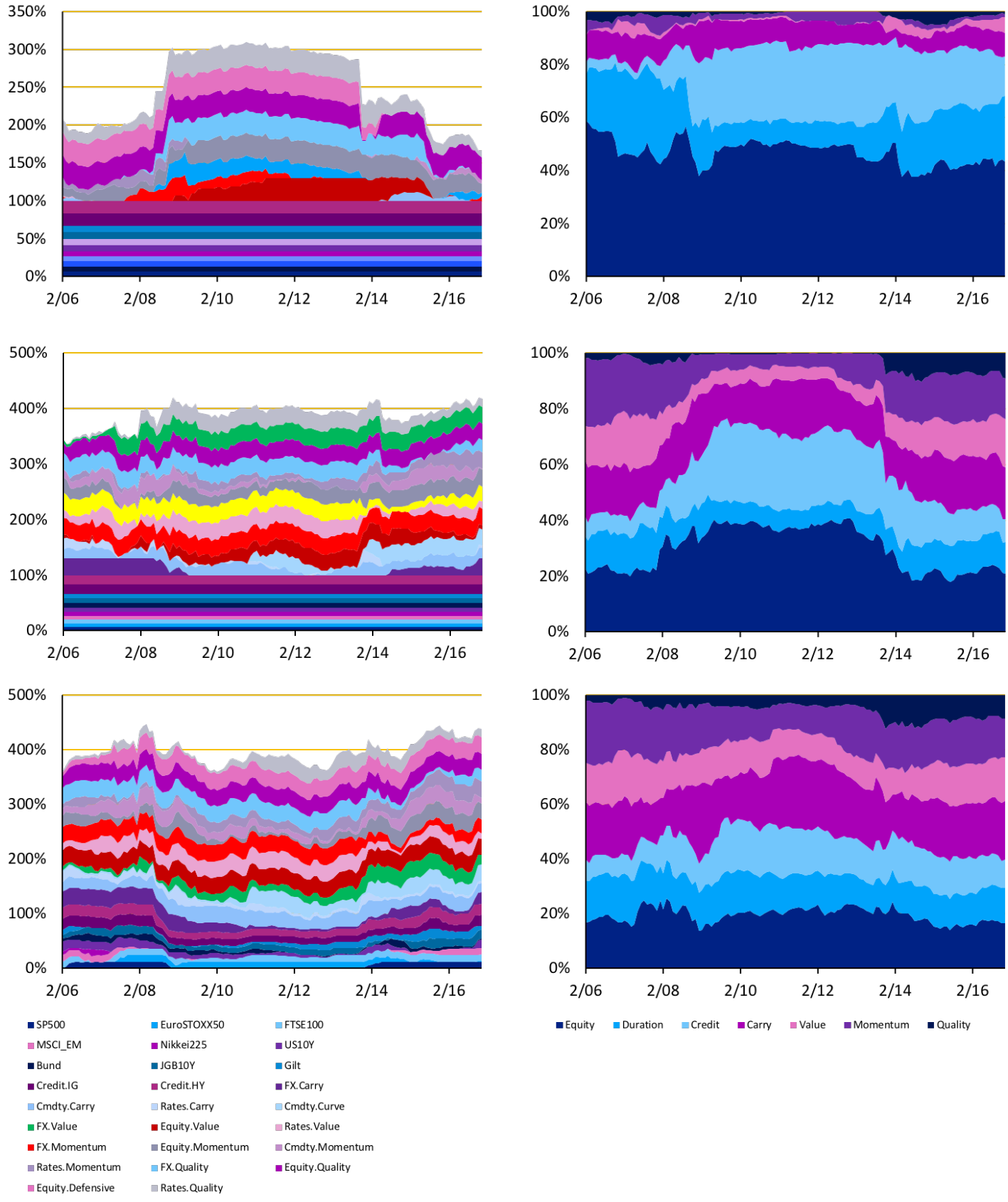


Exhibit 4: Multi-Asset Multi-Factor Strategies; weights and Risk Allocation
Source: Bloomberg, Invesco, Goldman Sachs. Data period: January 31, 2006 to December 31, 2016

Endnotes

This article was previously published in *Risk & Reward's* 1st issue of 2018.

1. See"Investing in a multi-asset multi-factor world," *Risk & Reward*, #3/2017.
2. To obtain risk-balanced aggregate asset class and factor returns, the aggregate factor return time series derive from a risk parity weighting of the underlying constituents. The set of constituents is the same as the one in *Risk & Reward* #3/2017, op. cit. Return calculations are from the perspective of a US-dollar investor; all returns are either in local currency or USD-hedged.
3. To this end, the set of three asset classes and four style factors are first translated into uncorrelated risk sources. Running a risk parity strategy along these uncorrelated risk sources then provides maximum diversification, cf. Lohre, Opfer and Orszag (2014), Bernardi, Leippold and Lohre (2018) and our previous analysis in *Risk & Reward* #3/2017.
4. The effective number of bets relates to the number of uncorrelated risk sources represented by a given allocation through time. Mathematically, it is computed as cf. Meucci (2009). For a completely concentrated portfolio, it holds that NEnt = 1, whereas for a fully diversified portfolio NEnt = 7.
5. Within asset class buckets, we assume a simple equal-weighted allocation scheme across the constituent single assets.

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A Panel Discussion on Hedge Funds

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Baker: Welcome to the panel discussion on hedge funds. Greg Filbeck and I are serving as the moderators. Our panelists are Hunter Holzhauer, Dianna Preece, and Andrew Spieler, all of whom contributed to Hedge Funds: Structure, Strategies, and Performance [2017]. The purpose of today's panel discussion is to provide a current look into the complex and rapidly changing world of hedge funds.

Let's begin by briefly defining a hedge fund and some of its basic characteristics. A hedge fund is a pooled investment vehicle that uses various strategies to invest in a variety of asset classes. Although hedge funds use numerous strategies, two common strategies are directional and absolute return. Directional refers to any strategy that entails taking a net long or short position in the market. Absolute return, also called market neutral, refers to any strategy that aims to produce positive and consistent returns in any market.

Hedge funds have the following characteristics:

- Are only open to "accredited" or qualified investors.
- Use leverage.
- Have limited transparency and liquidity.
- Have high fees and complex incentive structures.
- Are lightly regulated.
- Have wider investment latitude than many other types of pooled investments such as mutual funds.

Greg will now review the assets under management (AUM) and past performance of hedge funds.

Filbeck: As Table 1 shows, AUM for hedge funds excluding fund of funds (FOFs) more than doubled from $1,683.9 billion in 2010 to $3,537.7 billion in 2017. Hedge funds grew at an 11.09% compound annual growth rate over this period. By contrast, AUM for FOFs decreased by 42.4% from $561.7 billion in 2010 to $323.8 billion in 2017.

Year	Hedge Funds (Excluding FOFs)	Funds of Funds (in Billions of $)
2010	1,693.9	561.7
2011	1,710.0	532.4
2012	1,798.7	501.4
2013	2,156.7	473.6
2014	2,508.4	455.3
2015	2,796.6	440.2
2016	3,020.2	360.4
2017	3,537.7	323.8

Exhibit 1: Assets Under Management by Hedge Funds and Fund of Funds: 2010-2017
Source: Barclay Hedge (https://www.barclayhedge.com/research/indices/ghs/mum/Hedge_Fund.html and https://www.barclayhedge.com/research/indices/ghs/mum/Fund_of_Funds.html).

How have hedge funds performed in recent years? The answer to this question depends on the type of hedge fund examined. For instance, Barclay Hedge identifies 48 categories of hedge funds. Measuring hedge fund performance is difficult due to their private nature. Moreover, hedge fund databases suffer from various biases such as selection bias, survivorship bias, backfill bias, and liquidation bias. With these drawbacks in mind, let's review the annual performance of hedge funds, excluding FOFs, using Barclay's Hedge Fund Index. The Barclay Hedge Fund Index is a measure of the average return of all hedge funds excepting FOFs in the Barclay database. The index is simply the arithmetic average of the net returns of all reporting funds. Table 2 shows that between 2010 and 2017, the Barclay Hedge Fund Index underperformed the S&P 500 Index each year, except during 2015, and usually by a wide margin. This finding is not surprising, given that many hedge fund strategies would be expected to underperform the S&P 500 in a bull market, as experienced since early 2009.

Year	Hedge Funds (Excluding FOFs) (%)	S&P 500 Index (%)
2010	10.88	12.78
2011	-5.48	0.00
2012	8.25	13.41
2013	11.12	29.60
2014	2.88	11.39
2015	0.04	-0.73
2016	6.10	9.42
2017	10.36	19.42

Exhibit 2: Annual Performance of Hedge Funds: 2010-2017
Source: Barclay Hedge (https://www.barclayhedge.com/research/indices/ghs/Hedge_Fund_Index.html). S& P 500 Index (http://www.macrotrends.net/2526/sp-500-historical-annual-returns).

Having provided some background about hedge funds, let's now turn to our panelists to answer some questions on the following topics: (1) recent evidence, (2) hedge fund strategies, (3) hedge fund industry, (4) fee structure, (5) hedge fund activism, (6) scandals and taxes, (7) role of technology, (8) future trends, and (9) research opportunities.

Recent Evidence about Hedge Funds

Filbeck: Let's begin with a general question. What are some advantages and disadvantages of investing in hedge funds?

Holzhauer: The primary advantage of investing in hedge funds is the diversification benefit from adding another unique asset class to a portfolio. This diversification benefit is especially true in niche areas that are not often covered by traditional mutual funds and exchange-traded funds such as hedge fund targeting distressed companies, venture capital, and mergers and acquisitions. Besides diversification, some hedge funds offer protection against market corrections and recessions. In other words, hedge funds often advertise that they provide higher long-term risk-adjusted returns. Yet, as already mentioned, hedge funds as an asset class have typically underperformed the S&P 500 Index in recent years.

Spieler: I agree that hedge funds can offer diversification if they have low or uncorrelated returns relative to traditional equity and fixed income investments. Some hedge funds also offer unique strategies that are otherwise inaccessible to many market participants.

Filbeck: What disadvantages are associated with investing in hedge funds?

Holzhauer: The primary disadvantage of investing in hedge funds is fees. Some hedge funds may provide higher risk-adjusted returns, but distinguishing whether those returns are net of fees is important. Like most actively managed funds, hedge funds charge a standard asset management fee, usually 1% or 2% of AUM. However, unlike most other funds, hedge funds include a second and often quite substantial performance fee, which can be as high as 20% of the fund's return. Although some hedge fund managers have a reputation that may warrant extra compensation, the industry in general has felt considerable pressure to lower or even eliminate the performance fee. In fact, if the performance fees for hedge funds do not decrease, then many institutional investors such as endowments may continue decreasing their allocations in hedge funds.

Two other notable drawbacks for some investors include the opaqueness and illiquidity in the hedge fund industry. In general, the lack of transparency surrounding hedge funds creates uncertainty for investors, especially since many investors are not privy to the hedge fund's exact investment strategy and must rely on the manager's reputation. Compounding this uncertainty is the fact that most data tracking hedge funds is heavily biased as previously mentioned. Moreover, a chief concern for many investors is the illiquidity of investing in hedge funds. In most cases, investors must invest large sums to participate in a hedge fund and may be unable to get their funds back for several months or even years depending on the initial agreement. Some investors may perceive hedge funds as being too risky even if they can generate higher returns.

Preece: Although I'm unsure if it is actually an advantage or disadvantage, I think some behavioral factors are at play in hedge fund investing. For some individual investors, hedge funds represent an exciting, sexy type of investment that can make them feel like being part of the "cool crowd." I think this was especially true when hedge funds were somewhat shrouded in mystery and available almost by invitation only. Think about the Bernie Madoff scandal. Individuals and some institutional investors felt honored to be allowed to invest. I think some investors did not want to miss out and hence engaged in herding behavior.

Filbeck: Having discussed some of the pros and cons of investing in hedge funds, let's return to the question: How did hedge funds fair during and after the financial crisis of 2007-2008?

Spieler: From a performance perspective, caution is needed in overgeneralizing given the many sophisticated strategies that hedge funds use. Performance varied with some strategies designed to do well during recessions.

Holzhauer: I agree that some hedge fund strategies, such as managed futures, dedicated short funds, distressed company funds, and precious metals funds, are specifically designed to outperform the market – often even profit – during recessions. The financial crisis provided an interesting case study in hedge funds. In general, one of the biggest casualties of the financial crisis was not only the wealth of investors in the market, but also their trust in the market. Hedge fund managers especially felt the sting of losing investors' trust. Many investors associated hedge funds with various mortgage-backed securities and derivative products that contributed to the housing crisis. The loss of trust took its toll on the hedge fund industry. Although hedge funds like other asset classes have regained some of that trust, the industry's underperformance for most years since the financial crisis has created many questions for the hedge fund industry and increased the pressure for them to lower their performance fees.

Filbeck: The financial crisis of 2007-2008 was a rude awakening for many market participants. What lessons did the financial crisis teach about hedge funds?

Holzhauer: The financial crisis provides several takeaways for hedge fund investors. First, the most obvious takeaway is that the financial crisis provided a resounding call for more regulation, especially given that no other area of the market is less regulated that the hedge fund industry. Second, some investors learned much about the illiquidity in the hedge fund industry. They may not have realized how illiquid their holdings were until they tried to sell. Third, the correlation between most hedge funds and the overall market was higher than advertised. Many investors assumed their hedge fund investments would save them from a recession – not simply lose them a little less money. In other words, they didn't want to hear that the hedge fund industry only lost 18% on average in 2008 even if the S&P 500 market lost 38%. For many investors, the financial crisis painted a picture of greedy hedge fund managers too eager to increase performance to worry about the risk management they promised their investors.

Spieler: I want to reinforce the point about the importance of liquidity. Investors don't like illiquid assets in a bear market. Even the hedge funds that performed well during the financial crisis saw redemptions because investors were looking to get liquidity anywhere they could. Another lesson learned is that investors became much more aware of fees in negative or flat markets.

Holzhauer: I have one additional takeaway from the financial crisis for hedge funds. Investors often don't know what a hedge fund means much less what strategies hedge funds follow. For example, as Michael Lewis discusses in his book The Big Short [2010], there were both very big hedge fund winners and losers in the credit default swap (CDS) market during the financial crisis. In fact, only a few hedge fund managers bet against the collateralized debt obligation (CDO) bubble, which means that most hedge funds in the CDS market lost considerable money. Although Lewis' book was very popular and insightful, many investors may not realize the number of other types of hedge funds of which most are outside the CDS market. In short, most hedge funds – like almost all funds – still lost money during the financial crisis, but some hedge funds still outperformed by losing less than the market.

Hedge Fund Strategies

Baker: The next question involves a particular hedge fund strategy. Is the classic "long-short" strategy always viable?

Spieler: Yes. Presuming managers are actively picking winners and losers correctly the strategy is valid. I am hesitant to say "always" as investor preferences can change dramatically as could regulations – severe limitations on shorting would cripple this strategy. With this strategy, the opportunity exists to use leverage and earn "alpha" twice – both on the long and short. I'm attracted to markets where some investors can short but other investors generally can't such as mutual funds and pensions funds. As a result, these strategies work best when intra-stock correlations are low, which is a stock pickers market. However, after the financial crisis correlations have been quite high, which I think resulted at least in part by quantitative easing. During such periods, long/short strategies have a tough time,

which is evident in their relatively low risk-adjusted returns. The S&P 500 Index has had one of the best Sharpe ratios over this time period. Thus, being long/short during periods of high correlation and low volatility is a tough strategy. As quantitative easing reverses, a transition should occur from emphasis on monetary policy to fiscal policy. Such a climate offers the potential of creating more idiosyncratic winners and losers, which should work well for hedge funds following a long/short strategy.

Hedge Fund Industry

Baker: Let's now focus on the hedge fund industry. I'd like to get your views on three questions. The first question is: What is the current state on the hedge fund industry?

Holzhauer: The hedge fund industry has changed dramatically since its inception in 1949 when Alfred Jones created the first modern hedge fund. Today, hedge funds have several trillions of dollars in AUM. Despite impressive growth over the long term, several periods show lackluster growth such as during the high inflationary period in the late 1970s and 1980s and the financial crisis of 2007-2008. Yet, as shown in the introduction to this panel, the hedge fund industry continues to bounce back. Even despite the underperformance for the hedge fund industry since the last recession, the industry remains strong. In a 2016 survey conducted by Preqin [2016], 57% of the institutional investors surveyed report some allocation to hedge funds with nearly 90% of these investors allocating at least 5% to hedge funds. These numbers indicate that hedge funds are still a very popular alternative investment group.

Spieler: Saying that the current state of the hedge fund industry is "very bad" is tempting. True, many hedge funds have had little alpha generation in recent years. With 20/20 hindsight, one could easily show that a passive S&P 500 fund usually performed much better, net of fees, than the typical hedge fund in recent years. But the discussion is more nuanced. Certain parts of the hedge industry are quite healthy. One of the biggest challenges for small funds is fundraising. Sometimes, those responsible for allocating capital would rather be wrong in a crowd than to take the risk of using a non-mainstream manager. Other challenges are finding attractive pricing dislocations with markets near all-time highs and fee pressure. Fee pressure is broad based but the big marquee funds still garner a large premium. Breaking into the industry is likely harder today than a decade ago with fund count declining.

Another factor affecting the state of the hedge fund industry is consolidation. The bigger funds continue to grow while the smaller funds are struggling to raise enough capital to be economically viable. Fee compression is intensifying. Hedge funds are looking for strategies to attract new sources of capital, albeit at a lower fee.

Preece: I have a somewhat different view on the state of the hedge fund industry. I think for many investors the bloom is off the rose, so to speak. Weakening returns, a backlash against high fees, especially in the wake of poor performance, more accessibility, which means investors may not feel as special being "allowed" to invest in hedge funds, and a rash of scandals such as the Bernie Madoff scandal, SAC capital scandal, and others have all made hedge funds less attractive to many investors. Also, headlines found in publications such as The Guardian by Neate [2016], stating "Top 25 Hedge Fund Managers Earned $13 bn in 2015 – More than Some Nations" tend to annoy people as the Top 1%/99% debate rails on in the United States. I think it is truly a challenging time for hedge funds.

Baker: Let's now turn to the second question involving the hedge fund industry. "What challenges do hedge funds face in the current environment?

Spieler: Perception is a big challenge right now. The market has finally become one for stock-pickers. With the inevitable rise in global rates, active strategies may outperform the market and alternatives/diversifiers that are less correlated to equities play an integral role in a portfolio.

Given the less than stellar risk-adjusted returns since the financial crisis, I think clients are taking a harder look at hedge fund value propositions. I tend to think of the classic hedge funds as more of a differentiated fee structure, which works very well to the manager's advantage. What I think will occur over the next 5 to 10 years is further growth in the liquid alternative categories: that is, hedge funds within a mutual fund wrapper. Besides giving clients daily liquidity, the fees are likely to be much lower than today. These liquid alternative mutual funds can do everything a traditional hedge fund can do, so the question becomes why pay excess fees? As for traditional hedge funds, I think investors will allocate less money to them with a shift toward other alternative classes such as private equity, real estate, and infrastructure, which had more consistent returns since the financial crisis than hedge funds.

Preece: I believe one of the biggest challenges that hedge funds face is trying to invest such an enormous amount of capital. Even if some shine has worn off the appeal of hedge funds, hopeful investors are still looking for attractive returns. Since the financial crisis, many hedge funds have struggled to earn a return greater than that of passive investment strategies, which certainly are less costly to investors from a fee perspective. Yet, hedge funds had more than $3 trillion in AUM at the end of 2017. Some argue that hedge funds have turned into asset gatherers, trying to collect large management fees, and are less about generating high returns for investors.

One way to generate outsized returns is to identify market inefficiencies and exploit them. Doing so requires some highly skilled and talented managers. Yet, some funds have less talented managers and so much money to invest that identifying and exploiting potential opportunities becomes extremely difficult. I believe one of the biggest challenges facing hedge funds is trying to invest such an enormous amount of capital. Even if a bit of the shine has worn off the appeal of hedge funds, hopeful investors are still looking for

returns that beat a decade long period of extremely low bond returns. Stocks have performed well but an abundance of capital is still available. However, since the financial crisis, many hedge funds have struggled to earn a return greater than that of passive investment strategies, which certainly are less costly to investors from a fee perspective. Yet, hedge funds still managed more than $3 trillion in AUM, which is a large amount of capital to invest. Some argue that hedge funds have turned into asset gatherers, trying to collect large management fees, and are less about generating high returns for investors. One way to generate outsized returns is to identify market inefficiencies and exploit them. Doing this requires high skilled managers. With so much capital, some funds have less talented managers and so much money to invest that identifying and exploiting potential opportunities becomes very difficult.

Baker: The third question about the hedge fund industry is: What role do institutional investors play in the hedge fund industry?

Holzhauer: Three major types of institutional investors in the hedge fund space are pension fund managers, sovereign wealth fund managers, and endowments/foundations. Despite the general underperformance of many hedge funds compared to the market, especially since the financial crisis, many institutional investors maintain a robust weight in hedge funds and are positive on the long-term prospects for the industry. One of the main reasons is because institutional investors value the diversification that hedge funds provide. They also see some hedge funds as insurance policies that provide protection during market corrections and recessions. In other words, hedge funds are not going to disappear overnight.

For example, Marois [2014] reports that even when the highly influential CalPERS pension fund declared it was selling its entire $4 billion hedge fund portfolio, hardly any other pension funds followed suit. In fact, the only notable pension fund to follow in CalPERS footsteps was the Netherlands-based PFZW. The reason CalPERS' deallocation from hedge funds did not create a ripple effect is simple. Most pension funds only have a small weight in hedge funds, usually no more than 5%. In other words, any perceived risk could easily be mitigated by the perceived diversification benefit. Moreover, many hedge funds are designed to actually hedge risk, which is why they traditionally outperform the market in highly volatile, flat or even bear markets and underperform the market in less volatile bull markets. The more interesting trend to watch is likely to be with endowment funds, which allocate up to 50% of their portfolios to hedge funds. The low volatility and high returns of traditional mutual funds and ETFs following the financial crisis have put considerable pressure on endowments to reconsider their high allocation in more expensive and often less effective hedge funds.

Spieler: Yes, some institutional investors still make sizeable allocations to hedge funds. Although hedge funds can play an important role, I see allocations continuing to move away from traditional hedge fund mandates. Start-up hedge funds have greater difficulty succeeding today because institutional capital typically flows to the largest players and many of the FOFs are also allocating to the largest industry players.

Fee Structure

Filbeck: Let's delve into the topic of fee structure. Have the high fees paid to hedge fund managers resulted in high returns in the last few years?

Spieler: Absolutely not, especially when the comparison is made to equity markets. But most hedge fund strategies would be expected to underperform the S&P 500 index in a market like we have observed recently.

Preece: High fees have not resulted in high returns over the last few years. However, some argue that hedge funds provide better returns in bear markets even if they earn less in bull markets, as we've experienced in the stock market since early 2009. I'm not sure I believe it though as hedge funds suffered significant losses during the financial crisis. Hedge funds did outperform mutual funds and were not on the verge of collapse like banks, so perhaps in times of distress, hedge funds can play a positive role in a diversified portfolio.

Filbeck: As a follow-up, how is the fee structure changing for hedge funds?

Preece: After the financial crisis, a trend started to lower both management and performance fees. However, I think that some investors are willing to pay higher fees if the returns support it. The problem for the industry of late, however, is that the returns have not followed the high fees. This situation puts pressure on hedge funds to cut fees. Also, another trend is to create hedge fund-like strategies in mutual funds without hedge fund fees. If these funds are successful, they are likely to put even greater pressure on hedge fund managers to reduce fees.

Spieler: I agree. Evidence supports both trends.

Holzhauer: Hedge fund manager, Cliff Asness, once stated, "There's no investment so good that there's not a fee large enough to make it bad." This simple statement explains much of the negative sentiment around hedge funds. Even Warren Buffett has been vocal about the hedge fund industry charging high fees yet failing to outperform the market. In fact, in 2017, Buffett bet Protégé Partners $1 million that the S&P 500 index would beat a basket of hedge funds over the next 10 years. In 2017, he declared an easy victory. In a Preqin [2015] survey of hedge fund investors, 46% want to see an improved fee structure.

Hedge Fund Activism

Baker: Our next two questions focus on the subject of hedge fund activism. First, what has led to the rise in activism?

Preece: Hedge fund activism and investor activism in general are on the rise. Hedge funds often play an activist role in attempt to acquire a large number of shares of a public company and then use their stake to pressure the firm to provide them a seat on the board of directors. Famous activist investors include Carl Icahn and Bill Ackman. But smaller funds are also playing the activist role. For example, Tuesday Morning, which is a discount retailer, saw its shares increase by 15 percent in 2017 after two separate activist hedge funds announced they were trying to replace the company's CEO. What is interesting is that the CEO himself, Steven Becker, was an activist hedge fund manager. He ended up in the CEO position at Tuesday Morning after the company, following a battle with the activist hedge fund, agreed to put Becker on the board and fire the then CEO Kathleen Mason. Becker then liquidated his position in the activist fund and became the CEO of Tuesday Morning. Overall, activism is on the rise in the United States and is spreading to countries like the United Kingdom, which activists see as ripe with opportunity.

Spieler: I think we have seen more activism as hedge fund managers look to create alpha in a world with high correlations. Complacency at some board of directors and management teams is shockingly high, which allows activist to create meaningful value by pushing for change. Today, boards and management teams are more willing to listen to activists than they have historically, which creates a positive cycle for more activist campaigns. The biggest difference among activist strategies is whether they are trying to drive short-term value creation or truly long-term value creation. The level of due diligence and thought put behind suggestions also varies widely among different activists, with the ones that conduct much deeper due diligence often having much better outcomes for shareholders. Further, activism is partly due to a lack of attractive catalyst ideas with hedge fund managers trying to manufacture a catalyst.

Baker: How do the actions and intentions of activist investors differ?

Spieler: Activist investors tend to focus more on short-term returns. Although a long-term perspective may be discussed, the activist hedge fund managers may exit after earning profits.

Scandals and Taxes

Filbeck: Next, let's turn to the enticing subject of scandals. What are some examples of insider trading scandals that have rocked the hedge fund world?

Spieler: There are too many to list! SAC Capital and the Galleon Hedge Fund Insider Trading Scandal are both great examples.

Preece: Insider trading is trading on material, nonpublic information. Firms call it "edge" and many put pressure on traders to produce edge. The lines are blurry though and proving insider trading is often difficult to prove. As Andrew mentioned, one of the most famous insider trading cases is that of SAC Capital Advisors. SAC Capital was under investigation for insider trading. SAC Capital's CEO Steve Cohen said in a deposition about insider trading, that "it's vague." What was novel about the case was that the investigators used wire-taps, formerly reserved for investigations of mob activities. Although SAC Capital was fined a record $1.8 billion in a plea agreement where the firm admitted insider trading, founder Cohen was not criminally indicted on insider trading charges.

In contrast, in 2011, Raj Rajaratnam was found guilty of trading on information provided by corporate executives, traders, brokers, bankers, and directors of public companies. Rajat Gupta, a member of the board of directors of Goldman Sachs, provided Rajaratnam with information. Gupta served a two-year prison sentence for his role in the trading scandal. Hedge fund investing relies on information. While it may be difficult to prove, most firms are trying to get an edge. Some get caught, others do not, and still others may never cross the line, but it is hard to imagine they are not all trying to gain information that their competitor funds do not have, and that often is inside information.

Filbeck: Next, let's chat about taxes. How are hedge fund manager incomes taxed and has this been a subject of debate?

Preece: The tax treatment of hedge fund earnings has also been the subject of great debate dating back to when Mitt Romney was running for president. Critics attacked Romney for paying a lower tax rate that most of the Americans he represented based on the more attractive tax treatment of investment income. In particular, the 20 percent performance fee earned by hedge funds is taxed at the long-term capital gains rate of 20 percent instead of the ordinary income tax rate that once was 39.6 percent. This difference means hedge fund managers are afforded a substantial tax advantage over ordinary working citizens.

Spieler: Most hedge fund returns are taxed as long-term capital gains, if positions are held for more than one year, which is much less than ordinary income. Also, those recognizing off-shore gains can defer taxes

Role of Technology

Baker: What role does technology play in changing the hedge fund landscape?

Holzhauer: Over the last few years, the costs of technology have risen to represent more than 10 percent of the average hedge fund's budget. Rising complexity in the hedge fund industry requires hedge funds to incorporate new technology with regards to investing, investment options and reporting requirements. From an investing perspective, the single biggest disruptor to the financial markets over the last decade has been the steady rise of algorithmic trading. Algorithms offer hedge fund managers the potential to quickly capitalize on market inefficiencies and set an array of risk and return objectives. However, the impact that algorithms may have on each other and the overall health of the markets – especially the hedge fund market – is difficult to predict.

From an investment options perspective, new products such as ETFs – especially inverse and leveraged ETFs – have provided average investors with simple products for hedging and speculating on the market. For example, investors can now trade the VIX and the inverse of the VIX. Hedge fund managers will need to work harder to communicate to their clients about the dangers of holding some of these products for more than a day. In short, hedge fund managers will need to tell clients why some forms of investing should be left to professionals.

From a reporting perspective, hedge fund managers will need to invest in more complex data architectures and operational systems for managing a wider array of risks. HFs will also need to build more advanced infrastructure for linking front-, middle-, and back-office operations such as email, telephone, security, and data storage. Technology will also provide opportunities for smaller hedge funds to outsource some costly in-house services in order to improve margins. In contrast, larger hedge funds are likely to do less outsourcing as they take advantage of the economies of scale. In fact, a study by Ernst Young [2015] reported that about 75 percent of larger hedge funds have highly sophisticated tech systems for data and reporting. However, only about half of other (medium-sized and smaller) hedge funds do.

Spieler: As extension to what Hunter said, retail investors can now more easily replicate once-super complex quant strategies employed by hedge funds. One of the benefits of charging higher fees is that hedge funds can pay for more resources to try to extract alpha. The acceleration of big data and technology is a prime example. Hedge funds were first to pay for credit card data compiled by big data firms to have an edge on things such as same store sales for a particular retailer or by using satellite data of parking lots to assess traffic at certain department stores. The hard part of using technology is that the edge disappears quite quickly as others pay for the data and copy the approach, so continued investment needs to be made to look for the next cutting-edge data set that big data analytics can extract some predictive power.

Baker: Picking up on the theme of quantitative strategies, how has the emergence of fintech affected quantitative strategies and arbitrage strategies?

Spieler: The last few years have shown a big push for quant strategies at some of the big shops. The increased competition is making quant investing more difficult and inefficiencies are arbitraged out more quickly. Increases in black box/quant strategies will likely reduce the arbitrage opportunities in the market.

Future Trends

Baker: What is the likely impact of regulatory changes on hedge funds?

Holzhauer: In the aftermath of the financial crisis of 2007-2008 crisis, the Obama administration and Congress primarily focused on increasing regulations by passing legislation such as the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act). The Dodd-Frank Act included several reforms including the Volcker Rule, which restricts U.S. banks from making certain types of speculative investments that do not directly benefit their clients. Another example of increased regulation includes the Foreign Account Tax Compliance Act (FATCA), which requires many types of foreign entities such as financial institutions to report on foreign assets held by U.S. clients. Several other important pieces of legislation passed in other global markets. For example, in 2011, the Alternative Investment Fund Managers Directive (AIFMD) was passed in the European Union to regulate several types of investment funds including hedge funds. Many hedge fund managers are waiting to see the impact of increased regulation. For example, increased regulations are having a compounding effect on fees as several costs associated with compliance, such as increased prime brokerage fees, are passed on from brokers to hedge funds. Hedge fund managers are also worried that tax loopholes may eventually be closed including the current tax regulations that allow hedge fund managers to pay lower taxes on capital gains than taxes on ordinary income. In the short term, hedge fund managers are paying close attention to changes in the political landscape. For example, the regulatory tune obviously changed somewhat in 2016 with the election of President Trump, who is seen as a champion of deregulation. That said, only time will tell if any substantial deregulation policies concerning hedge funds are passed while President Trump is in office.

Spieler: I would say increased disclosure, but the future is uncertain with the Trump administration.

Baker: What future trends are likely to occur in the hedge fund industry that could lead to areas ripe for research?

Spieler: Driven by investors, expect to see more consolidation and fee compression.

Holzhauer: Any discussion on trends must consider the role of technology. Technology will force hedge funds to lower their fees as technology increases more investment options and provides investors with leverage to negotiate more favorable terms.

Setting aside the rippling impact of technology, the most general long-term trend is growth – especially by institutional investors. In fact, some experts are predicting that the growth in the hedge fund industry will outpace the market. Citi Investor Services [2014] predicted that the hedge fund industry will nearly double from $2.63 AUM in 2013 to $4.81 trillion AUM in 2018 – with nearly three-fourths of the growth coming from institutional investors. The number of hedge funds has also been increasing to meet investor demand. As evidence, Delevingne [2015] reports that hedge fund investors can choose from an estimated 10,149 hedge funds and FoFs as of March 2015. In other words, the hedge fund industry has finally crested over the previous high-water mark of 10,096 hedge funds previously set in 2007 before the financial crisis of 2007-2008. Still, short-term uncertainty remains in the hedge fund industry, which has recently triggered substantial divestment. Much of this recent divestment can be attributed to underperformance in the hedge fund industry compared to the overall market since the financial crisis. A large portion of the hedge fund industry is simply not designed to compete with long bull markets with low volatility. Considering that all markets are somewhat cyclical, a future rise in volatility or a strong market correction or even mild recession should favor the hedge fund industry.

Dissecting the growth trend further, many hedge funds are flirting with new approaches to growth. One clear example is the rise in diversity among hedge fund managers with more female hedge fund managers, more minority hedge fund managers, and even more socially conscious hedge fund managers focused on the rise in socially responsible investing (SRI) and impact investing. Size will also dictate some growth patterns. For example, larger hedge funds currently seem more focused on increasing the penetration of existing products or funds while smaller hedge funds are trying to get new investor bases in existing markets. The end result will likely be that larger hedge funds will continue to get even larger while smaller hedge funds will likely perform better. The primary reason for this trend is that larger hedge funds appear safer to investors while smaller hedge funds are often nimbler and better suited to focus on a particular niche in the market.

Spieler: As previously mentioned the use of big data is a huge trend in hedge funds and will lead to extensive research opportunities. Managerial career concerns present another research opportunity.

Filbeck: Our time has come to an end. Kent and I would like to take this opportunity to thank each of our panelists for participating in this enlightening discussion.

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Since receiving her doctorate in finance from the University of Kentucky in 1990, Dianna has taught corporate finance, investments, and bank management at both the undergraduate and graduate levels at the University of Louisville. Dianna received her CFA charter in 2004. She also teaches in several banking schools nationwide. In recent years Dianna's research has focused primarily on investments and the stock market and has appeared in numerous academic and practitioner journals such as Review of Financial Economics, Journal of Investing, Financial Services Review, and Journal of Banking and Finance.

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University of Tennessee at Chattanooga

Hunter Holzhauer is the UC Foundation Associate Professor of Finance at University of Tennessee at Chattanooga. Since 2013, Hunter has coauthored 15 papers that have been accepted for publication by peer-reviewed journals. Hunter has also authored six chapters for a range of different books on investments including two chapters on hedge funds. Hunter does most of his research and teaching in investments and behavioral finance. In addition to his research and teaching duties, Hunter is the Faculty Director for the UTC Student Managed Investment Learning Experience (SMILE) Fund and the Faculty Advisor for the UTC CFA Research Challenge team.

The CAIA Endowment Investable Index

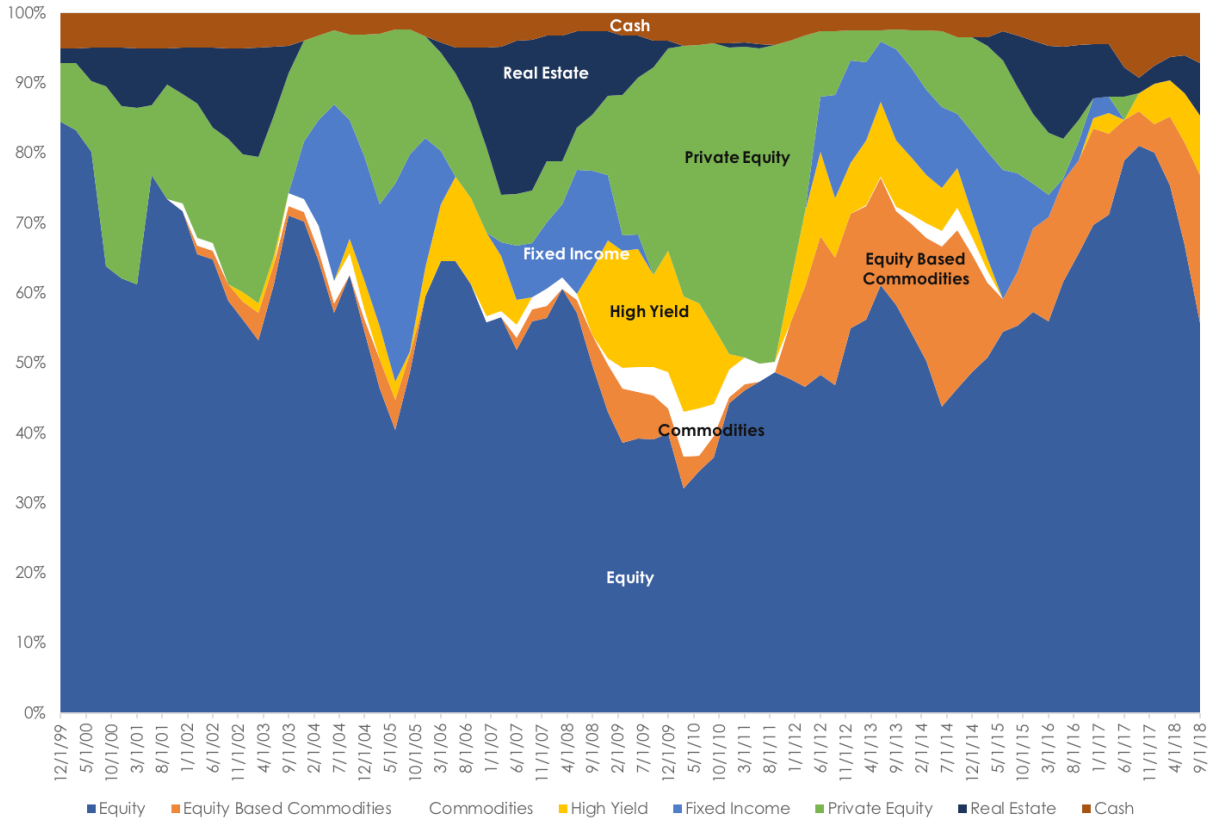
Hossein Kazemi

Kathryn Wilkens, *CAIA*
Pearl Quest

We present the historical weights, allocation as of month-end September 2018, and historical performance to the replication portfolio that was introduced in our AIAR publication Volume 6 Issue 1.

The below graph shows the exposures of the Multi-Asset ETF portfolio through time. It is important to note that the volatility displayed by these exposures does not imply that endowments alter their asset allocations as frequently as the Multi-Asset ETF portfolio. While an endowment may hold a fixed allocation to various asset classes, the underlying assets/manager may display time-varying exposures to different sources of risk. For instance, a hedge fund manager may decide to increase her fund's exposure to energy stocks while reducing the fund's exposure to healthcare stocks. Though the endowment's allocation to that manager has remained unchanged, its exposures to energy and healthcare sectors have changed. Also, if returns on two asset classes are highly correlated, then the algorithm will pick the one that is less volatile. For instance, if returns on venture capital and small cap stocks are highly correlated, then the program will pick the small cap index if it turns out to be less volatile.

Endowment Index Weights



Allocation Suggested by Algorithm

Russell 2000 ETF	Power Shares QQQ ETF	MSCI World Free ETF	Materials Select Sector SPDR® ETF	Energy Select Sector SPDR® ETF	Health Care Select Sector SPDR® ETF	BBgBarc US Corporate High Yield TR USD	SPDR® Dow Jones Global Real Estate ETF	Cash & Short-Term Treasuries
14.35%	21.94%	14.91%	16.60%	4.63%	4.51%	8.40%	7.63%	7.03%

Historical Performance

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Dr. Hossein Kazemi is the Senior Advisor to the CAIA Association's Program. Dr. Kazemi has been involved with the CAIA Association since its inception as a senior advisor and a managing director. In his current role, he helps with the development of the CAIA program's curriculum and directs the CAIA Association's academic partnership program. In addition, he serves as the editor of *Alternative Investment Analyst Review*, which is published by the Association. He has worked with universities and industry organizations to introduce them to the CAIA program. Dr. Kazemi is Michael and Cheryl Philipp Distinguished Professor of Finance at the Isenberg School of Management, the University of Massachusetts - Amherst. He is the Director of the Center for International Securities & Derivatives Markets, a nonprofit organization devoted to research in the area of alternative investments, a co-founder of the CAIA Association, and home to CISDM Hedge Fund/CTA Database and the *Journal of Alternative Investments*, the official research publication of the CAIA Association. He has over 25 years of experience in the financial industry and has served as consultant to major financial institutions. His research has been in the areas of valuations of equity and fixed income securities, asset allocation for traditional and alternative asset classes, and evaluation and replication of active management investment products. He has a Ph.D. in finance from the University of Michigan.

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Kathryn Wilkens is the president and founder of Pearl Quest LLC, a consulting company currently focused on tracking and replication products, and educational services in the alternative investments space. She is also an RIA with S Capital Wealth Advisors and assistant editor for the *Journal of Alternative Investments*.

About CAIA

Founded in 2002, the CAIA Association is the world leader and authority in alternative investment education. The CAIA Association is best known for the CAIA Charter (www.caia.org), an internationally-recognized credential granted upon successful completion of a rigorous two-level exam series, combined with relevant work experience. Earning the CAIA Charter is the gateway to becoming a Member of the CAIA Association, a global network of more than 9,000 alternative investment leaders located in 90+ countries who have demonstrated a deep and thorough understanding of alternative investing. The CAIA Association now supports 30 vibrant chapters located in financial centers around the world and sponsors more than 150 educational and networking events each year.

The List: Alternative Indices

	Ending Sept 2018				
	1 Yr	5 Yr	10 Yr	Ann. Vol	Draw-down
MSCI World Free	11.84%	9.89%	9.18%	16.47%	-30.88%
Barclays Global Agg	-1.38%	0.17%	2.25%	7.20%	-10.20%
MSCI Emerging Markets	-0.44%	3.99%	5.76%	21.92%	-27.56%
Barclays Global High Yield	0.27%	4.85%	9.22%	12.42%	-18.29%
HFRI Fund Weighted Composite	3.93%	4.10%	4.55%	6.54%	-9.19%
CISDM EW Hedge Fund	4.13%	4.94%	5.65%	7.15%	-9.13%
CISDM CTA EW	2.64%	5.16%	4.16%	6.76%	-7.93%
CISDM Distressed Securities	4.93%	4.39%	6.17%	7.13%	-12.48%
CISDM Equity Long/Short	5.21%	5.60%	6.21%	6.26%	-7.82%
CA US Private Equity	18.51%	13.46%	12.02%	8.07%	-18.77%
CA US Venture Capital	19.66%	14.98%	11.01%	8.07%	-14.67%
LPX Mezzanine Listed Private Eqty	6.52%	7.27%	4.39%	32.89%	-70.95%
FTSE NAREIT All Equity REITs	4.69%	9.65%	7.81%	24.85%	-58.31%
NCREIF Property	7.16%	9.57%	7.40%	5.71%	-23.75%
S&P Global Property	1.65%	6.13%	6.42%	21.61%	-43.82%
S&P Global Infrastructure	-2.84%	6.14%	6.06%	16.04%	-30.81%
Bloomberg Commodities	2.59%	-7.18%	-6.24%	17.37%	-53.55%
NCREIF Timberland	4.00%	5.99%	4.01%	3.61%	-5.69%
NCREIF Farmland	6.83%	9.89%	11.64%	4.85%	0.00%
Alternative Assets Portfolio	**9.59%**	**9.08%**	**7.75%**	**6.56%**	**-17.27%**
Global 60/40	**6.49%**	**6.05%**	**6.77%**	**10.41%**	**-17.74%**
60% Portfolio/40% Global 60/40	**7.74%**	**7.28%**	**7.22%**	**8.47%**	**-17.51%**

Source: CAIA, CISDM, HFRI, Cambridge Associates and Bloomberg.

The performance table below is a collection of both traditional and alternative indices for the 1, 5, and 10-year period annualized through September 2018. Both the annualized volatility and draw-down figures are calculated using a 10 year quarterly return series.

Alternative investments have been growing markedly over the past few years, creating a multitude of opportunities for owners and allocators alike. As the number and type of alternative asset classes continue to proliferate, we believe they are playing a more unique role in assisting investors achieve their desired investment outcomes. As we expect this trend to continue, we found it necessary to structure a pure alternative assets portfolio to have visibility in this exciting marketplace.

We set out to strike a balance between available assets in proportion to their market value, and to reflect the average "alternative investor". We defined the investment opportunity to simply be the following three assets classes: Real Asset, Private Equity/Venture Capital, and Hedge Funds. Real assets are comprised of real estate, commodities, timberland, farmland, infrastructure, bank loans, and cat bonds; within real asset the weights were structured to reflect the market portfolio[1] within that universe. To arrive at our weight's, we researched various endowments and foundations, as well as surveys conducted by Willis Towers Watson and Russell Investments. Based on our research, alternative historical allocations have not had material deviation and therefore we decided to implement a market weight of 1/3 across each of those asset classes. A few of the constituents are not investable, and some may be reported gross or net of fee.

1. Global Invested Capital Market by Hewitt EnnisKnupp, an Aon Company

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