



The Wrapper Matters: Comparing Liquid Alternatives and Hedge Funds

Chris Tidmore
Vanguard Investment
Strategy Group

Daniel B. Berkowitz
Vanguard Investment
Strategy Group

In a potential low-return environment, investors are continuously seeking to improve a portfolio's risk-return profile.¹ Using alternative investments is one option, though evaluating strategies is a challenging task for practitioners at all levels of experience.² The first part of our paper provides a framework that investors can use to evaluate the returns from strategies across public and private vehicles. Studying a manager's past returns through a variety of lenses, however, is one step in a multistep portfolio construction process. The second part of this paper provides portfolio construction commentary and analysis that practitioners may use to guide an investment decision.

Comparing Structures

We begin by briefly comparing the private and public structures that investors use to gain access to these types of strategies. We center our analysis on the pooled fund structure commonly used by both. Hedge funds predominantly operate as private placement vehicles through the general/limited partnership model. Although the limited partnership legal structure can limit an investor's liability in the fund to the amount of capital contributed, these agreements are negotiated, are generally nontransferable, and can impose restrictions on investments.

We refer to "liquid alternatives" throughout the paper as the public implementation of hedge fund strategies. Liquid alternatives are commonly discussed as a group of broadly accessible vehicles for alternative investment strategies that generally maintain low correlations to traditional asset classes. For the purposes of our research, the liquid alternatives category includes products such as mutual funds, exchange-traded funds (ETFs), and exchange-traded notes (ETNs). Exhibit 1 further summarizes key structural differences, broken into a few major categories.

		Liquid alternatives	Hedge funds
Regulatory oversight		Greater regulation. Most are regulated under the Investment Company Act of 1940 ('40 Act) as pooled investment vehicles.	Less regulation. Largely exempt under the '40 Act if offered to accredited investors/qualified purchasers.
Fees and access	Investment management fees*	Lower <ul style="list-style-type: none"> • Asset fee. 	Higher <ul style="list-style-type: none"> • Asset fee. • Performance fee.
	Typical Investment minimums	Lower – Typically \$5,000 to \$250,000.	Higher – Typically \$1 million to \$5 million.*
Transparency	Specificity of strategy disclosure	Yes – more standardized reporting through prospectuses and quarterly/annual reports.	Some – though often less standardized.
	Holdings disclosure	Yes – through quarterly reporting.	Varies – can be difficult to obtain.
	Pricing frequency and quality	Greater – daily pricing with more standardization.	Varies – frequency is often monthly
Liquidity provisions	Restrictions on sales	No – investors can redeem daily.	Yes – with lockup and gating provisions, among others.
	Leverage limitations	Yes – at least 300% asset coverage must be maintained (Explicit leverage limit).	No – though based on manager discretion.
	Liquidity requirements	Yes – 85% of a fund's net assets must be held in liquid investments that the fund reasonably expects can be sold within seven calendar days without significantly changing the market value. 15% of net assets can be held in "illiquid" investments	No – though based on manager discretion.
	Shorting requirements	Yes – the full value of liabilities created by using short sales must be covered by holding an equivalent amount of collateral within a separate brokerage or custodial account.	Portfolio margining – aligning margin requirements with the overall risk of the portfolio's positions

Exhibit 1: Structural Differences between Public and Private Vehicles are Notable

Source: Vanguard, Citi Prime Finance (2013); U.S. Securities and Exchange Commission; Investment Company Institute; Chambers, Black, and Lacey (2018); and Philips (2006).

* Additional fees may apply depending on structure, including platform fees, marketing fees, load fees, audit fees, and administrative fees. Some liquid alternatives may charge performance fees, but those are less than comparable hedge fund fees.

^ See Steme and Slattery (2002)

Notes: Some characteristics addressed in the exhibit are generalizations. Because much of our data sample consists of U.S. liquid alternatives and hedge funds, the exhibit focuses on the U.S. regulatory framework. Regulations differ around the globe, though other major frameworks (Such as UCITS) have similar restrictions on the public fund characteristics described here.

A few key differences emerge from this comparison. Liquid alternatives grant investors various benefits and protections that private vehicles do not, such as holdings transparency and daily pricing/access. Relative to private counterparts, however, many liquid alternative vehicles are constrained in the use of leverage, liquidity, shorting, and derivatives because of greater regulatory oversight.³ These portfolio management tools allow hedge funds to both take more risk and hedge more flexibly. Notably, these characteristics are critical in design and implementation for many of these alternative investment strategies. This implies that the execution of the strategies themselves in a liquid alternative vehicle may look materially different on a category-by-category basis. The ensuing analysis explores this point in greater detail.

Strategy Mapping Framework

To conduct our analysis, we created a mapping framework to group seven subcategories of strategies into five headline categories for ease of comparison.⁴ Such a framework provides a more useful comparison between categories in public and private form because data providers often use different classification systems (Exhibit 2). The framework was created by mapping categories of hedge funds from the Hedge Fund Research (HFR) database (a robust, detailed classification system) to categories used by Morningstar, Inc., to group liquid alternatives (mutual funds, ETFs, and ETNs). We used fund and category descriptions to rearrange certain categories, finalizing the mapping exercise. See Appendix A for more on our data set and methodology.

Headline category	Definition	Liquid alternatives subcategories	Mapped hedge fund subcategories	Other strategies included in the headline category
Long/short equity	Funds that take long and short (hedging) positions in equities, equity ETFs, and related derivatives using fundamental or quantitative processes.	<ul style="list-style-type: none"> Long/short equity Marketing neutral 	<ul style="list-style-type: none"> Long/Short equity (ex-equity market neutral) Market neutral 	<ul style="list-style-type: none"> Quantitative directional Fundamental growth/value Sector-specific Short-bias Multistrategy
Relative value	Funds that seek to capitalize on mispricings between various securities including equities, fixed income, and derivatives, using fundamental or quantitative techniques	Long/short credit	Fixed income: corporate	<ul style="list-style-type: none"> Fixed income: convertible arbitrage Fixed income: sovereign Volatility Yield alternatives Multistrategy
Event driven	Funds that invest in equity or fixed income securities that are currently or prospectively involved in corporate transactions including mergers and acquisitions, financial distress, and capital restructurings.	Event-driven	Event-driven	<ul style="list-style-type: none"> Activist Distressed and restructuring Merger arbitrage Special situation Credit arbitrage Multistrategy
Global macro	Funds that use systematic or discretionary strategies based on movements in macroeconomic variables and trends and their impact on various asset classes (equities, fixed income, commodities) and instruments (currencies, derivatives).	<ul style="list-style-type: none"> Managed futures Multicurrency 	<ul style="list-style-type: none"> Systematic diversified Currency 	<ul style="list-style-type: none"> Commodities Discretionary thematic Active trading Multistrategy
Multistrategy	Funds that use strategies that are a combination of major categories or subcategories above. Multistrategy approaches are often designed to blend various strategies to reduce the volatility of the overall return stream and correlation to traditional asset classes.	Multialternative	Fund of funds (FOF)	<ul style="list-style-type: none"> FOF conservative FOF diversified FOF market defensive FOF strategic

Exhibit 2: Alternative Investment Strategies in a Public and Private Wrapper

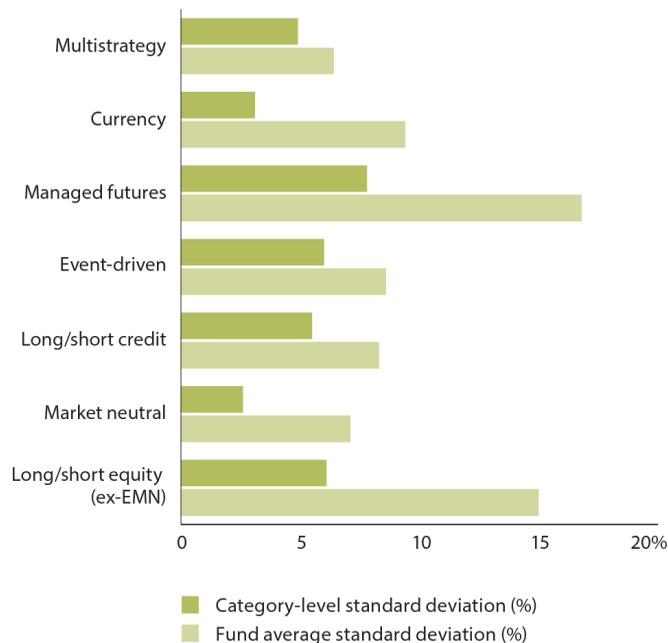
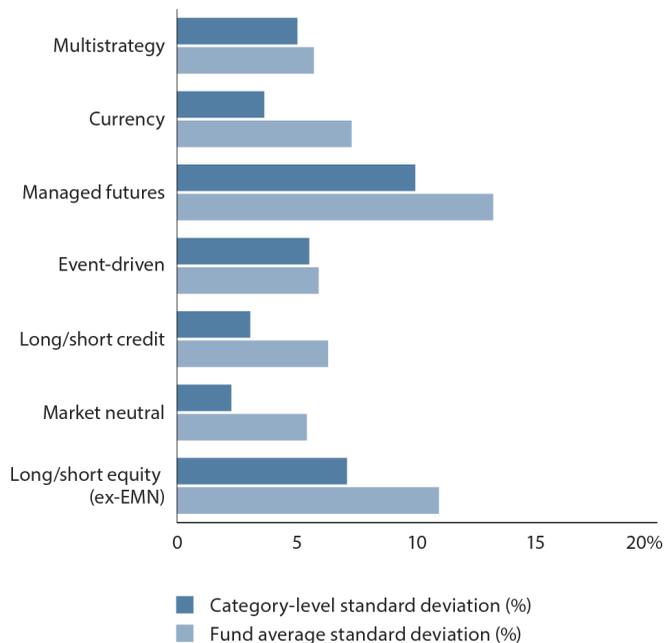
Source: Vanguard

Notes: Definitions are adapted from HFR definitions, Morningstar definitions, and Goldman Sachs Asset Management (2019). See Appendix A for select subcategory definitions. Mapped hedge fund categories are the closest matches from HFR based on available categories. In our mapping framework, some headline categories lack differentiated subcategories. The last column lists additional strategies from HFR that are not explicitly analyzed in the research; the list is not all-inclusive.

Categories Versus Individual Funds

Although a natural place to begin examining these strategies is through categories (as represented by indexes or aggregations of managers into a single return stream), such a starting point presents challenges. By combining the returns of hedge fund or liquid alternative fund managers into a single stream, we reduced the manager (idiosyncratic) risk component that investing in individual funds entails. Generally, this biases down the standard deviation of the index return stream, as the pairwise correlations between individual managers is often less than one. Exhibit 3 highlights the larger standard deviation for individual funds relative to their category averages and intracategory fund correlations.

Nonetheless, using categories of strategies is an appropriate starting point to assess their performance and portfolio construction benefits. Categories of liquid alternatives and hedge funds are not widely investable, but they are generally representative of how a strategy type behaves.⁵ In addition, individual liquid alternatives and hedge funds either have notoriously short lifespans or provide limited return history (see Figure A-1 in the Appendix). This complicates the use of individual funds in broad, comparative analysis.⁶



	Long/short equity (ex-EMN)		Market neutral		Long/short credit		Event-driven		Managed futures		Currency	Multistrategy		
Average fund pairwise correlation	0.5	0.4	0.2	0.1	0.7	0.5	0.8	0.4	0.8	0.4	NA	0.0	0.7	0.7

■ Liquid alternative category
■ Hedge fund category

Exhibit 3: Masking Manger Risk?

Source: Vanguard calculations; based on data from Morningstar, Inc., and HFR.

Notes: Funds included in the sample reported complete data over the measurement period of July 2003 through June 2018 except currency hedge funds, for which a shorter data requirement was used to match the category-level time series. The currency liquid alternative category had fewer than five funds with full return history, so no correlation was computed.

Performance Comparison

Performance Snapshot

We begin with a performance snapshot of constituent category funds over our measurement period (July 2003 through June 2018). Exhibit 4 presents return distributions for our headline category and subcategories and shows that hedge funds exhibit a higher median and wider dispersion of net returns across all categories compared with liquid alternative counterparts.

It is difficult to truly compare these types of strategies in public and private form. Because of limited reporting requirements for hedge funds, managers may not mark to-market the value of their holdings with the same frequency and transparency as liquid alternative counterparts. See Asness, Krail, and Liew (2001) for additional discussion. Nonetheless, the frameworks we used to compare and analyze these investments are a valuable reference point for investors.

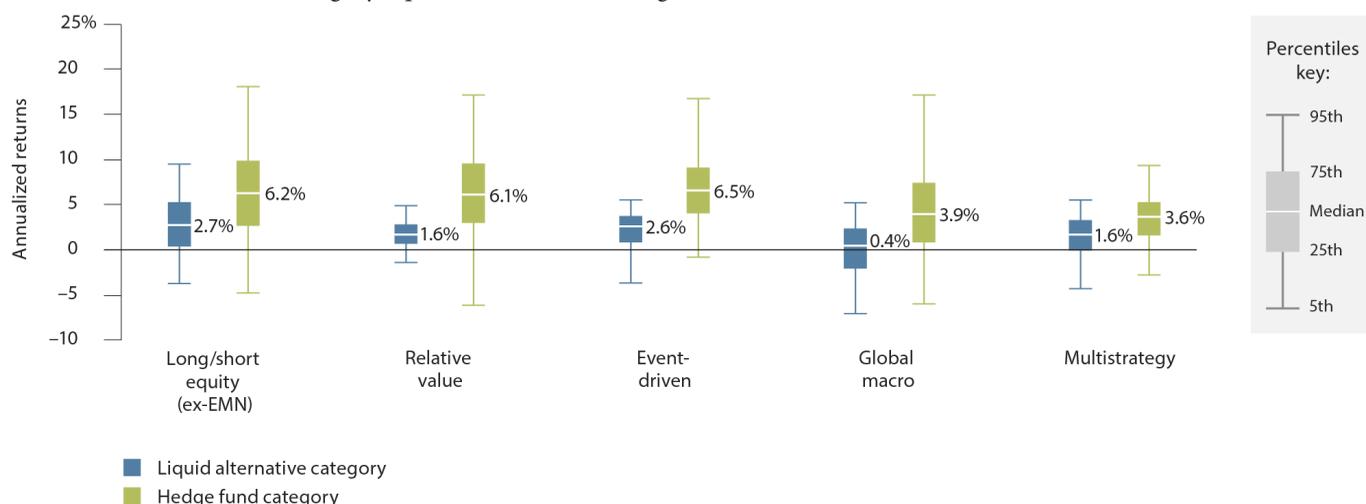
The lower medians and tighter dispersion of liquid alternative returns reflect, in part, their more limited use of leverage and other portfolio management tools discussed in Exhibit 1. Investors can evaluate these lower returns as the cost of increased regulatory and structural protections and as a potential hedge

against the more extreme outcomes visible in the hedge fund data. The value of these protections depends on an investor's unique objectives and risk preferences.

Although we analyzed strategy categories for much of this research, the dispersion in Exhibit 4 demonstrates that, as with many types of alternatives, investors should follow a bottom-up portfolio construction approach when allocating to any strategy. This is because managers' risk exposures can vary widely depending on the underlying strategy design and will most likely behave in a materially different way from the category as a whole.⁷ See "Manager selection is mission-critical" on page 25 for more detail.

For much of the rest of the analysis, we used HFRI indexes and comparable, equal-weighted liquid alternative category fund averages to assess the characteristics of our strategy categories. See Appendix A for descriptive statistics for our hedge fund/liquid alternative categories, global equity, and global fixed income.

A. Headline category liquid alternative and hedge fund returns



B. Subcategory liquid alternative and hedge fund returns

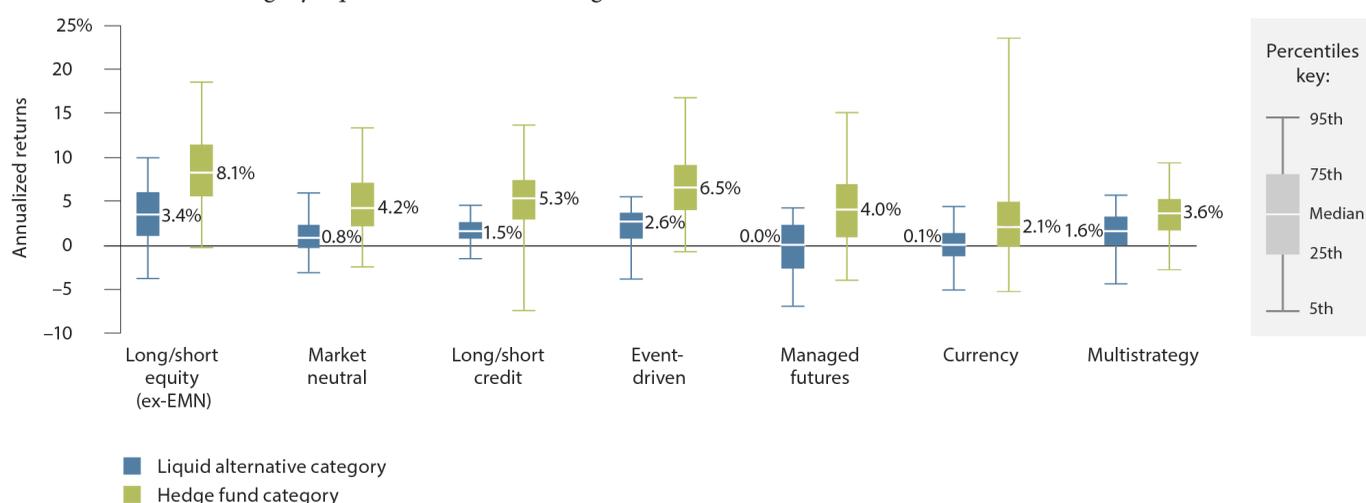


Exhibit 4: Hedge Funds Outperform their Public Peers, Though with Greater Return Dispersion

Source: Vanguard calculations; based on data from Morningstar, Inc., and HFR.

Notes: Return distributions include annualized returns for funds that were alive at any point during the 15 years from July 2003 through June 2018 and had at least 36 months of return history. Funds with less than 36 months of data were removed from the sample to improve data quality. The long/short credit hedge fund category includes fixed income (sovereign) funds from HFR. Returns are net of fees. Past performance is no guarantee of future returns.

A few points of note:

- Hedge fund Sharpe ratios were often notably higher than their liquid alternative counterparts.
- Hedge funds exhibited lower correlations to global equities and global fixed income across most subcategories, but differences often were not substantial. In addition, some strategy correlations and betas (to both global equity and fixed income) were highly time-varying over the 15-year measurement period. See “Additional portfolio construction considerations” on page 26 for more detail.
- All liquid alternative and hedge fund categories underperformed global equities over our measurement period, but this benchmark is not appropriate for the majority of strategies. In fact, the majority of the constituent funds in our seven categories underperformed global equities’ 9.15% annualized return over our measurement period as well. Many also underperformed global fixed income’s 3.68% annualized return. Benchmarking for these types of strategies is beyond the scope of this paper.⁸

A. Liquid alternative annualized alpha



B. Hedge fund annualized alpha



Exhibit 5: Hedge Funds Still Outperform their Liquid Alternative Counterparts after Adjusting for Risk

Source: Vanguard calculations, based on data from Morningstar, Inc., and HFR. See Appendix B for factor definitions and sources.

Exhibit 5: Cont.

Analyzing Returns through a Factor Lens

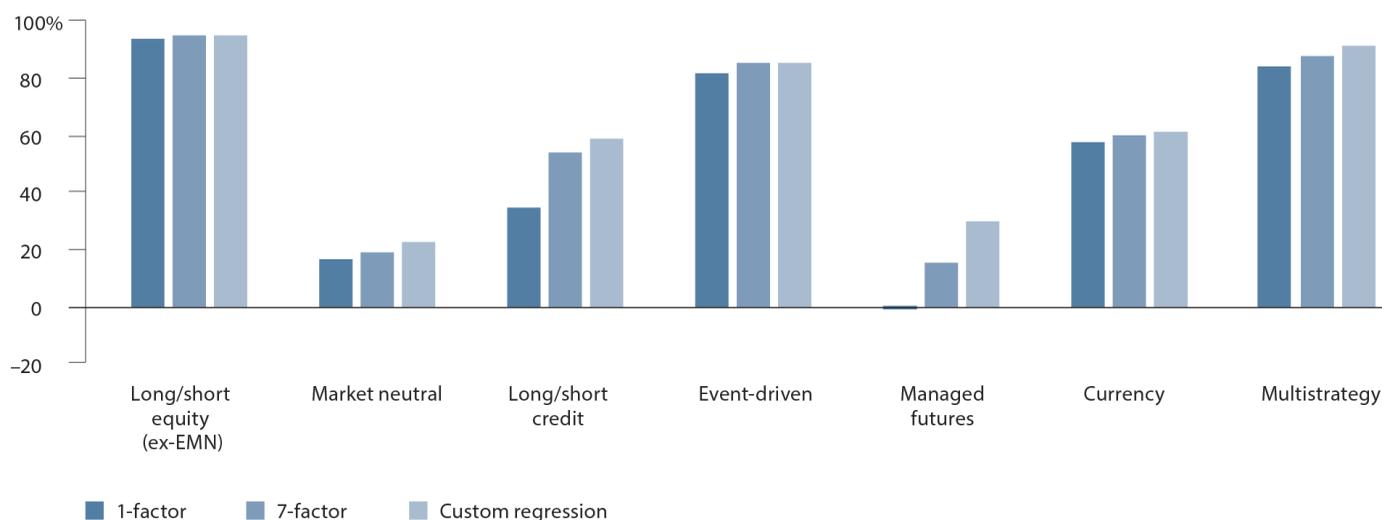
These performance differences can potentially be explained by a few considerations, including the structural differences discussed in Exhibit 1 and biases in hedge fund data.⁹ To address whether these, and other, considerations informed the performance differences shown in Exhibit 4, we controlled for risk by regressing categories of gross, hedge fund, and liquid alternative excess return streams on various risk factors using three different regression model specifications:¹⁰

- 1-factor (market).¹¹
- 7-factor (Fama-French-Carhart 4-factor with term, investment-grade credit, and high yield).
- Custom regression (“custom”) using a broad array of risk factors widely cited in academic literature to explain hedge fund returns (see Appendix B for factor definitions and sources) or conduct risk factor attribution. Additional factors include liquidity, low volatility, quality, and trend-following factors.

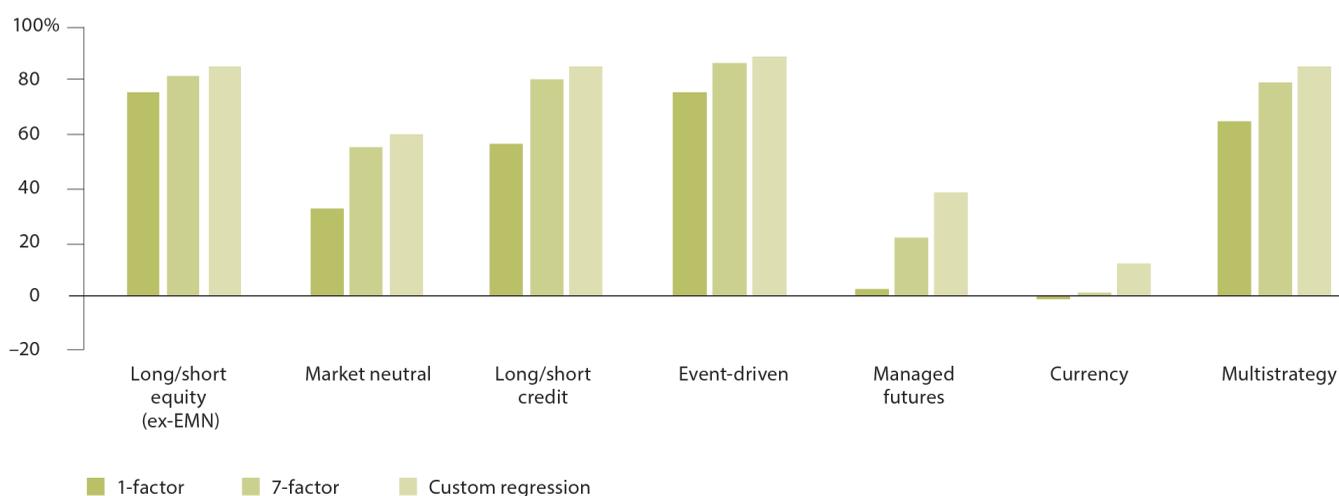
Because we used global liquid alternative and hedge fund data, all factors covered global risk premiums to whatever extent possible. In addition, because liquid alternative and hedge fund vehicles can implement strategies long/short, we used long/short factors; such factors also removed collinearity that would likely otherwise exist across our independent variables. Finally, all excess returns and factors are gross of cost and reported in USD.¹²

Exhibit 5 reports the alphas and adjusted R-squared results from our regressions. Because we used a gross-of-cost assumption to obtain a purer measure of ex-post performance, our regression results should be interpreted as the value-add that managers generated, not what investors realized, over our measurement period. In addition, our research does not focus on forward-looking replication for our various strategy categories.¹³ See Appendix B for the full regression output, including betas and t-statistics.

C. Liquid alternative adjusted R-squared



D. Hedge fund adjusted R-squared



Notes: Annualized alphas were calculated by multiplying regression intercepts by 12. Data cover July 2003 through June 2018. The custom regression specification was run through December 2017 because of liquidity factor data limitations. The currency hedge fund regressions were run starting December 2008 because of data limitations.

Exhibit 5 Cont.

Consistent with findings from academic literature, hedge fund categories outperformed their liquid alternative peers after accounting for differing levels of risk through three different regression specifications.¹⁴ Alphas were greater almost across the board. Most hedge fund alphas were statistically significant to 5% as well. Although the adjusted R-squared results from our liquid alternative regressions were similar to those from our hedge fund regressions, the liquid alternative R-squareds were slightly higher—a conclusion we expected given the daily pricing and greater liquidity provided by public vehicles.¹⁵

We hypothesize that measuring alphas net of cost would shrink the gap between the liquid alternative and hedge fund categories shown in Exhibit 5. At the very least, hedge funds charge higher management fees (and performance fees) on average than liquid alternatives. In turn, hedge fund alphas should bear a disproportionately larger negative impact when studied on a net basis.

Notably, a unique combination of the 15 risk factors we tested explained individual strategy returns over our measurement period. Factor exposures differ across liquid alternative and hedge fund categories, reflecting the difference in strategy implementation for the public and private vehicles. Exhibit 6 details statistically significant factors from the custom regression specification for both liquid alternatives and hedge funds. It also highlights the more complex set of risk factor exposures that drove most hedge fund category returns relative to liquid alternative counterparts (as represented by the number of green squares relative to the blue squares).

	Long/short equity (ex-EMN)	Market neutral	Long/short credit	Event-driven	Managed futures	Currency	Multistrategy
Market	Blue	Blue		Blue	Blue	Blue	Blue
Size	Green			Green			
Value	Diagonal Green						Diagonal Purple
Momentum	Blue	Green		Green	Blue		Blue
Low volatility	Green	Blue	Blue	Gray			Blue
Quality			Diagonal Purple	Diagonal Green			Diagonal Purple
Liquidity	Blue						Blue
Bond Trend							
Currency trend			Blue		Blue	Green	Blue
Commodities trend		Diagonal Green		Diagonal Green	Green		
Short rates trend		Diagonal Green	Diagonal Green	Diagonal Green			Diagonal Green
Stock trend					Blue		Blue
Term		Diagonal Green	Blue	Gray	Green	Blue	Blue
Investment-grade credit		Green	Green	Diagonal Blue			Green
High yield	Blue	Diagonal Green	Blue	Blue			Blue

Liquid alternative factor:		Hedge fund factor:		Both factors:	
Blue	Positive Beta	Green	Positive Beta	Blue	Positive Beta
Diagonal Blue	Negative Beta	Diagonal Green	Negative Beta	Diagonal Purple	Negative Beta
				Gray	Positive/negative beta

Exhibit 6: A Diverse Array of Factors Drives Returns

Source: Vanguard calculations; based on data from Morningstar, Inc., and HFR.

Notes: Risk factor in the highlighted cells were statistically significant to at least 5% in the custom regression specifications. Gray squares represent a statistically significant factor for both liquid alternatives and hedge funds where one beta was positive, and one beta was negative. See Appendix B for betas and t-statistics.

Liquid Alternatives Are Often the Prudent Option

Even assuming that a hedge fund, on average, could outperform a similar liquid alternative, investors may still prefer the public option, which may be a better choice when accounting for the considerations discussed in Exhibit 1. Many investors have preferences or constraints related to the use of leverage, liquidity, shorting, and derivatives in their portfolios; pricing transparency for holdings; and the ability to access capital with limited restrictions. These constraints may preclude an investment in many hedge funds.

And as discussed in the next section, liquid alternatives may provide valuable portfolio construction benefit for investors who are not interested in undertaking the additional due diligence required for, or paying the costs associated with, investing in private alternatives. A few considerations that are particularly relevant for private investments relative to public counterparts are presented below; see Wallick et al. (2015) for more detail on the challenging nature of hedge fund due diligence.

Fee Structures. Hedge funds often have both management and performance fees, which can substantially lower an investor's net return. Fee structures can also be complex, with added high-water marks and hurdle rates. In addition, to build a diversified hedge fund allocation, some investors choose to invest in hedge funds through a fund-of-funds structure (which often adds another layer of fees).

Holdings Transparency and Pricing Frequency. Unlike liquid alternatives, to protect proprietary trading strategies, many hedge funds will not provide specific detail on portfolio holdings (and are not required to as mutual funds and ETFs are). This can be problematic for investors looking to assess how a manager's strategy may blend with traditional assets. In addition, the daily pricing of liquid alternatives gives investors a far more consistent snapshot of investment performance.

Access to Capital. Liquid alternatives allow investors to access their investments daily—a highly valuable benefit, particularly for those who have spending requirements or who regularly rebalance their portfolios to maintain a target asset allocation. Hedge funds provide less liquidity by allowing investors to redeem less frequently (for example, quarterly or longer), with additional gating provisions, lockup periods, redemption queues, and other considerations. In most market environments, hedge funds usually provide more liquidity than other private alternatives such as private equity, but in more stressed environments, many hedge funds can become extremely illiquid.

From Analysis to Implementation

Studying the returns from these alternative investment strategies is one important step in a more holistic, multistep portfolio construction process. One of the most critical steps is manager selection. Selecting an active manager is a challenging task for investors and investment professionals alike. This is particularly true for those focused on alternative investments, whose strategies are often complex and may not be fully transparent. The performance dispersion across and within categories of hedge fund and liquid alternative managers shown in Exhibit 4 underscores this point. More specifically, because managers can deliver a wide range of outcomes (especially in private vehicles), a strong manager selection process is key to “improving the odds of success.

A Framework for Portfolio Construction

Although a deeper dive on strategy and manager due diligence for hedge funds and liquid alternatives is beyond the scope of this paper, we provide brief commentary below. For a more comprehensive review, with a particular emphasis on private investments, see Greenwich Roundtable (2010).

1. Identify an investment objective

Being explicit about an investment objective, and how a manager or strategy may help achieve it, is an important first step. Investors may use liquid alternatives and hedge funds to target a wide array of objectives, ranging from broader (such as return enhancement, portfolio diversification, or inflation protection) to narrower (such as achieving a specific target rate of return above inflation). These objectives are typically not mutually exclusive.

After identifying an objective or objectives, investors who are willing and able to select these types of managers can proceed with the bottom-up portfolio construction process—determining whether to invest through a public or private vehicle and eventually selecting a manager after thorough review. As discussed throughout this paper, investors will place varying degrees of value on the relative benefits that public liquid alternatives provide. This is critical to assess up front.

2. Determine a suitable strategy type(s)

Before selecting an individual manager, winnowing down the opportunity set of strategy types to an intended one or few can be helpful. This determination should be informed by an investor’s portfolio construction preferences and constraints.¹⁶ Various strategies can provide a wide range of benefits but are

often implemented differently. Investors should carefully review how a strategy’s design and execution mesh with these key considerations.

For example, from a design perspective, an investor interested in absolute return produced from equity security selection might focus more on the equity market neutral category. Another investor interested in harvesting alternative risk premiums systematically (with less manager discretion) might spend more time searching for a multistrategy or global macro manager with a transparent, quantitative orientation. In addition, certain strategies use much more leverage, short-selling, and derivatives than others. These considerations should all be carefully evaluated. Investment consultants can also help with this decision.

3. After assessing the potential benefits and risks, select a manager(s)

Upon identifying an objective and strategy type, investors should assess what ex-ante portfolio construction benefit might be achieved from a specific manager. Such analysis will help in determining, for example, an allocation’s size and funding source. Investors can start by examining and decomposing a manager’s past returns through time using, for instance, the types of analyses we present in the first portion of this paper. The metrics and analyses used should be matched to the objective.

For example, an investor seeking inflation protection through a global macro strategy should assess the extent to which a fund’s returns generally maintain a strong correlation and beta to an inflation rate such as the Consumer Price Index and why they should be expected to do so in the future. An investor seeking to improve a portfolio’s return using a long/short equity strategy should spend substantial time setting return expectations (and certainty around them) for the fund and measuring them against those of other investment options.¹⁷ And if a strategy type is expected to produce a return distribution that is highly nonnormal, traditional mean-variance statistics may not be appropriate to use.¹⁸

4. Evaluate periodically

As with any other investment decision, it is prudent to periodically assess the benefits of an allocation ex-post. Once a decision is made, investors should document their definitions of success and evaluate a manager against those expectations. Documenting decision-making criteria throughout the process is also important. Addressing considerations such as those below are a helpful way for investors to determine whether the benefit of an allocation is still being achieved. For example, assess whether:

- The allocation met the intended portfolio construction objective.
- The investor’s risk tolerance or portfolio construction preferences/constraints have materially changed.
- The manager consistently executed upon the stated strategy.
- Other funds/strategies are now available that might help improve the odds of achieving an intended objective.

Manager Selection is Mission-Critical

The importance of manager selection for both public and private vehicles cannot be overstated. Because many investors do invest in individual hedge funds or liquid alternatives, and because individual funds pursue a wide range of investment strategies intracategory, individual funds can produce a wide dispersion of results in a portfolio construction setting. Exhibit 7 provides two examples of sets of efficient frontiers for multistrategy liquid alternatives and hedge funds.

To test how multistrategy funds interact with traditional assets, we run backward-looking mean-variance optimization over our 15-year measurement period with a portfolio of global equity, global fixed income, and an array of individual multistrategy managers to isolate the benefits of blending in an allocation. Examining changes to efficient frontiers is a straightforward way to assess the risk–return benefit of including a new investment in a portfolio. In our example, the multistrategy allocation is fixed at 40% along the frontier, and global equity/fixed income are unconstrained. Fixing the allocation at 40% better represents how investors’ portfolio outcomes would have looked had they held a significant allocation to these managers through time.

We compare these individual manager frontiers to a base-case frontier containing global equity, global fixed income, and the multistrategy category average. Clearly, individual funds can produce a wide array of outcomes, both adding or subtracting value relative to category averages. Although not shown here, this conclusion applies to all categories of liquid alternatives and hedge funds. Because of the limited data history for many hedge funds and liquid alternatives, we chose funds that reported over the full measurement period for this analysis. We recognize that this may not be a representative sample from the multistrategy population, as funds that die off (or stop reporting returns) may do so because of poor performance.¹⁹

Purely approaching portfolio construction by relying on category averages for strategy types (that is, the base-case frontier in Exhibit 7) can present misleading results because of both the inability to capture the category average and the potentially wide variability of outcomes across managers.²⁰ Instead, Exhibit 7 shows that investors who can identify, access, and hold top-tier managers through time in both public and private vehicles can improve a portfolio’s risk-adjusted return profile, by either reducing overall volatility or increasing return, or both.²¹ The opposite, however, holds true for investors who have selected underperforming managers.

Portfolio Construction Preferences and Constraints Matter

Two more portfolio construction considerations are important to discuss. First, the funding source for an allocation matters. The optimization in exhibit 7 tended to allocate to our alternative strategies from the equity portion of the portfolio (in particular, to create the low-risk efficient mix).²² For investors with various preferences or constraints on funding source, this can erode the benefits from a portfolio construction perspective. For example, over our 15-year period, if an investor wanted to keep an equity allocation intact to maintain portfolio growth targets (and instead had to fund an allocation primarily from fixed income), the results of our optimization would appear quite different—the benefit might be reduced in the form of a lower Sharpe ratio.

Second, we test 40% maximum allocations in our analysis. This is a large allocation to a highly complex investment and greater than many investors may feel comfortable with. We do so to magnify impact for research purposes. Smaller allocations, however, may not add significant portfolio construction value (namely, a small Sharpe ratio improvement in exhibit 7). In particular, investors may need to judge whether a potential marginal benefit is worth the added portfolio complexity or cost if a consultant is engaged or a fund-of-funds structure is chosen to assist with manager selection.

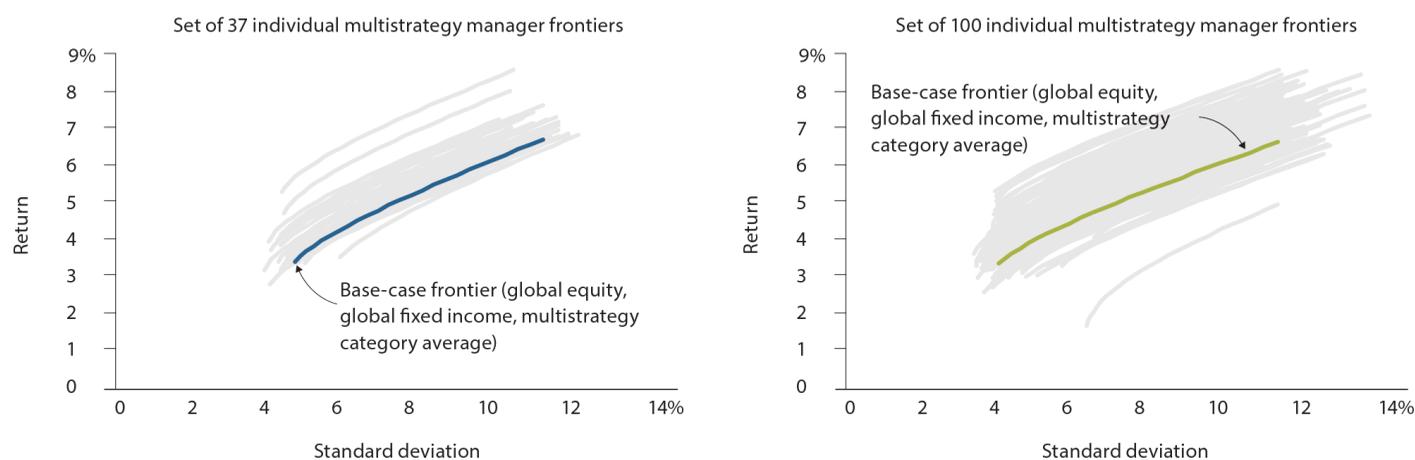


Exhibit 7: Manager Risk can Increase the Variability of Portfolio Outcomes

Source: Vanguard calculations; based on data from Morningstar, Inc., and HFR; and FactSet

Notes: Data cover July 2003 through June 2018. Each line represents an efficient frontier with an allocation to an individual liquid alternative or hedge fund manager, global equity, and global fixed income. The 37 liquid alternatives represent the total number of funds that survived over our measurement period. The 100 multistrategy hedge funds represent a sample of the funds that had a full return history over the period. Global equity is represented by the FTSE Global All Cap Index, and global fixed income is represented by the Bloomberg Barclays Global Aggregate Bond Index. The multistrategy category average for hedge funds is represented by the HFRI Fund of Funds Composite Index. Liquid alternative and hedge fund returns are net of fees. Past performance is no guarantee of future returns. The performance of an index is not an exact representation of any particular investment, as you cannot invest directly in an index.

Additional Portfolio Construction Considerations

A targeted benefit may be inconsistent through time

Although investors can clearly find value with an above-average manager, a targeted benefit may ebb and flow through time. More specifically, Exhibit 8 shows that shorter-term correlations and betas (here, rolling 36-month) can fluctuate widely, particularly for certain strategy types.²³ For example, the rolling global equity correlation for the managed futures and market neutral hedge fund categories was less stable over our measurement period than for other strategies. Most fixed income correlations and betas presented a cyclical trend as well.

From an investor's perspective, formulating expectations of how a manager's strategy may respond in various macroeconomic conditions is important. Although Exhibit 8 presents the time-varying nature of these key portfolio construction statistics for our category averages, individual funds may maintain similar time-varying correlations and betas as well. A thorough assessment of the enduring nature of a manager's philosophy and prior stability through time can both be informative data points.

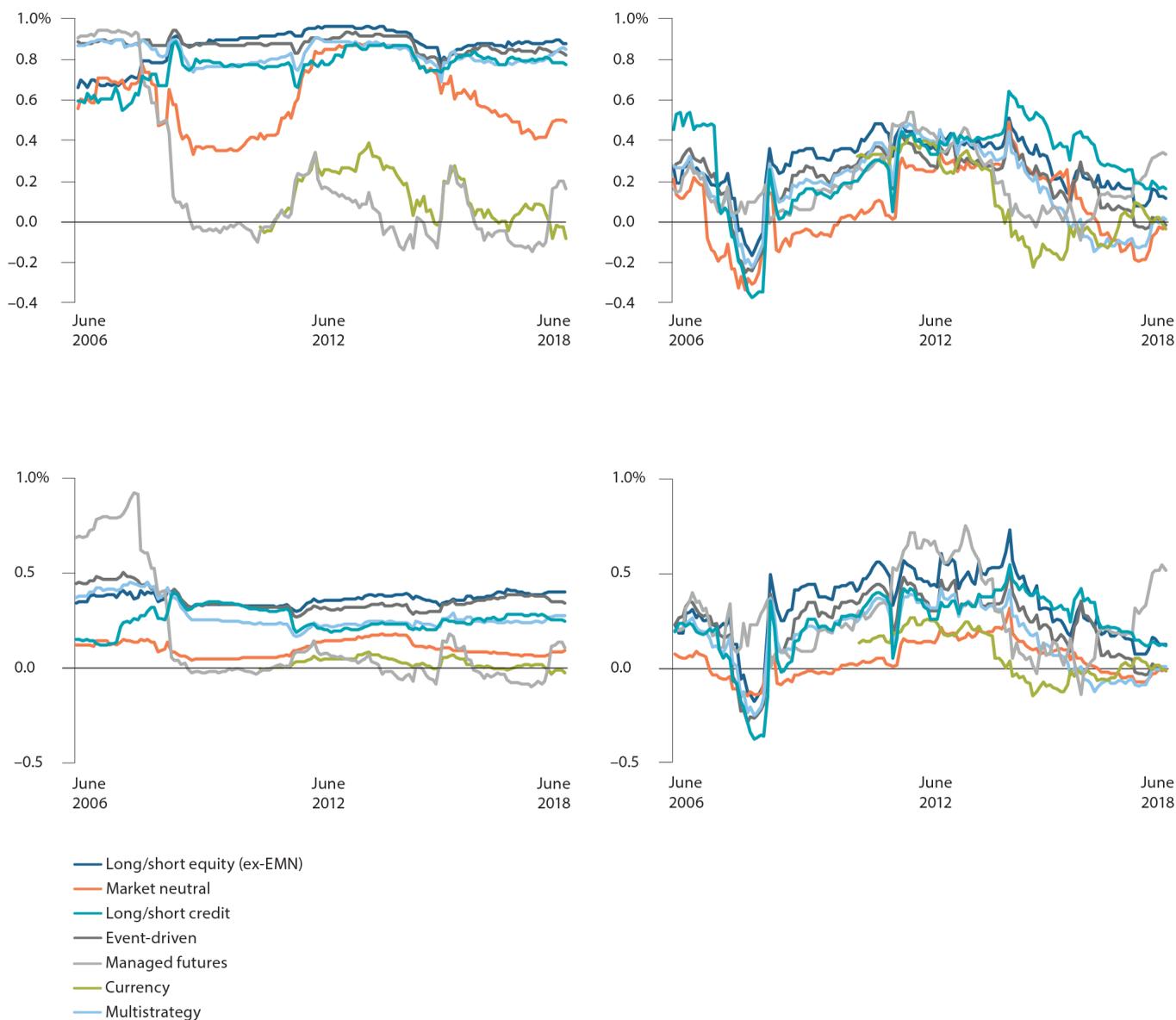


Exhibit 8: Key Portfolio Construction Statistics may be Time-Varying

Source: Vanguard calculations; based on HFR

Notes: The exhibit presents statistics for hedge fund categories. We also ran the same analysis for liquid alternatives, which showed similar time-varying trends. Data cover July 2003 through June 2018. Because of data limitations, the time series for the currency category starts January 2008. Correlations and betas are calculated relative to the FTSE Global All Cap Index and the Bloomberg Barclays Global Aggregate Bond Index. Betas are calculated using excess returns over cash.

Blending Alternative Investment Strategies Can Smooth the Ride

For investors interested in an additional layer of diversification, blending these strategies may be prudent. Exhibit 9 shows mixed results for correlations of hedge fund and liquid alternative category excess returns. Some strategies provided more of an intracategory diversification benefit than others during the measurement period.

The global macro category (including managed futures/currency) and the market neutral strategy were the best diversifiers between subcategories based on the average from each sample of managers in each category. The multistrategy category already represents a combination of a few strategy types, but we found some benefit to continuing to diversify it with other strategies. Although we use category averages to generalize below, investors seeking to combine individual hedge funds or liquid alternatives should conduct such an exercise on a fund-by-fund basis to assess how ex-post diversification benefits might inform ex-ante assumptions.

Conclusion

Investors are continuously seeking ways to improve a portfolio's risk–return profile. Our research demonstrates that certain investors who are comfortable with the implications of investing in liquid alternatives and hedge funds should carefully consider them. While categories of hedge funds have outperformed their public counterparts, liquid alternatives are often a viable option for investors who value the greater regulatory protections, ease of access, and lower costs they provide. Although both public and private vehicles can deliver valuable portfolio construction benefits, it is crucial that investors assess funds on a standalone basis, as the benefit from any alternative investment allocation will be dictated by the specific strategy of the manager(s).

A. Liquid alternative categories

	Long/short equity (ex-EMN)	Market neutral	Long/short credit	Event-driven	Managed futures	Currency	Multistrategy
Long/short equity (ex-EMN)							
Market neutral	0.55						
Long/short credit	0.69	0.47					
Event-driven	0.94	0.45	0.68				
Managed futures	-0.08	0.13	-0.14	-0.19			
Currency	0.71	0.52	0.78	0.65	-0.04		
Multistrategy	0.94	0.57	0.75	0.87	0.03	0.74	

Correlation:

- >0.7
- 0.3–<0.7
- <0.3

B. Hedge fund categories

	Long/short equity (ex-EMN)	Market neutral	Long/short credit	Event-driven	Managed futures	Currency	Multistrategy
Long/short equity (ex-EMN)							
Market neutral	0.65						
Long/short credit	0.81	0.51					
Event-driven	0.93	0.62	0.91				
Managed futures	0.02	0.15	-0.16	-0.08			
Currency	0.09	0.13	-0.04	0.05	0.46		
Multistrategy	0.92	0.71	0.82	0.91	0.15	0.16	

Correlation:

- >0.7
- 0.3–<0.7
- <0.3

Exhibit 9: Many Strategies are Imperfectly Correlated, Further Improving Diversification

Source: Vanguard calculations; based on data from Morningstar, Inc., and HFR

Notes: Data cover January 2008 through June 2018. Hedge fund and liquid alternative returns are in excess of cash and net of fees.

Appendix

Appendix A. Data Set and Methodology

Liquid alternatives data: from Morningstar, Inc.

- Individual funds: Global funds were used provided that they report returns in USD (base currency). Funds needed at least 36 months of returns to be included in fund-level performance analysis. All share classes were included.
- Categories: We constructed a return stream representing the equal-weighted average returns of all funds (live and dead) in the category to approximate the HFRI index methodology. Mutual funds, ETFs, and ETNs were included.
 - The “event-driven” category was custom-created using Morningstar data.
 - The “options-based” category was split apart and reallocated to the remaining categories (with many funds moved into the “long/short equity” category).
 - The “bear markets,” “volatility,” and “trading” categories were excluded from our mapping framework.

Hedge fund data: from Hedge Fund Research (HFR).

- Individual funds: Global funds’ onshore and offshore vehicles reporting in USD were used. Funds needed at least 36 months of returns to be included in fund-level performance analysis.
- Categories: We selected HFRI indexes, which are widely used for gauging hedge fund performance. HFRI monthly indexes are designed to reflect industry performance by constructing equally weighted composites of funds. To be considered for inclusion, all funds had to report performance monthly, net of all fees, and in USD. Constituent funds had to have either at least \$50 million in assets under management or a track record greater than 12 months.
 - The HFRI Currency Index began reporting in 2008, so a shorter time series was used for the currency category.
 - Our “long/short equity ex-market neutral” category was custom-created and is not published by HFR. Because Morningstar separately classifies market neutral strategies, we analyzed the category separately. Market neutral strategies may behave significantly differently from other long/short equity strategies that are more directional in nature.
 - We used funds of funds for our multistrategy hedge fund category, as they typically represent a blend of managers pursuing diverse objectives across headline categories (comparable to the structure of liquid alternative multistrategy funds). The “other strategies” multistrategy funds in Figure 2 represent a blend of strategies within one particular headline category and are not as diversified as funds of funds across strategy type.

Time period: Unless otherwise specified, our measurement period covers the 15 years beginning July 1, 2003, and ending June 30, 2018.

Cost assumptions: Unless otherwise specified, liquid alternative and hedge fund returns are net of fees. No cost assumptions are applied to our global equity and fixed income indexes, as these exposures can be obtained at very low cost.

Definitions and descriptive statistics for strategies

Select subcategory definitions

Definitions for certain subcategories are provided that are materially different from the headline category presented in Figure 2. Although there are often differences across hedge fund and liquid alternative implementation, the definitions that follow provide a general snapshot of the strategy for both categories. The definitions were adapted from HFR or Morningstar or both.

Market neutral

These funds seek to reduce systematic risk created by factors such as exposures to sectors, market-cap ranges, investment styles, currencies, and/or countries. They try to achieve this by matching short positions within each area against long positions. These strategies are often managed as beta-neutral, dollar-neutral, or sector-neutral. Funds in this category are distinguished by their typically low beta exposures to market indexes such as the MSCI World Index. In seeking to reduce systematic risk, these funds emphasize issue selection, with profits dependent on their ability to buy and sell securities long/short.

Long/short credit

These funds seek to profit from changes in the credit conditions of individual bond issuers and credit markets segments represented by credit indexes. Typically, portfolios purchase bonds, or sell credit default swaps, expecting to profit from narrowing credit spreads; or the funds sell bonds, or purchase credit default swaps, expecting to profit from the deteriorating credit of the underlying issuer. This category includes funds that use credit derivatives to hedge systematic risk of credit markets to isolate credit selection returns.

The “fixed income: corporate” hedge fund category is mapped to long/short credit. This category includes strategies that employ an investment process designed to isolate attractive opportunities among a variety of fixed income instruments, typically realizing a spread between multiple corporate bonds or between a corporate bond and a risk-free government bond.

Managed futures

These funds primarily trade liquid global futures, options, swaps, and foreign exchange contracts, both listed and over-the-counter. A majority of these funds use trend-following, price-momentum strategies. Other strategies in this category are systematic mean-reversion, discretionary global macro strategies, commodity index tracking, and other futures strategies. Often, much of a fund’s exposure is invested through derivative securities. These funds obtain exposure primarily through derivatives; the holdings are largely cash instruments.

The “systematic diversified” hedge fund category is mapped to managed futures. Systematic diversified strategies have investment processes typically as functions of mathematical, algorithmic, and technical models, with individuals having little or no influence over the portfolio positioning. The category includes strategies that use an investment process designed to identify opportunities in markets exhibiting trending or momentum characteristics across individual instruments or asset classes.

Currency

Currency portfolios invest in multiple currencies by using short-term money market instruments; derivative instruments, including and not limited to forward currency contracts, index swaps, and options; and cash deposits. Funds include systematic and discretionary strategies.

	Long/ short equity (ex-EMN)	Market neutral	Long/short credit	Event- driven	Managed futures	Currency	Multistrategy	FTSE Global All Cap Index	Bloomberg Barclays Global Aggregated Bond Index
Annualized return	4.11%	1.42%	3.08%	2.92%	2.81%	1.55%	3.05%	9.15%	3.68
Standard Deviation	7.16%	2.27%	3.12%	5.56%	10.06%	3.67%	5.09%	14.95%	5.64%
Sharpe ratio	0.41	0.11	0.61	0.32	0.16	0.10	0.37	0.53	0.44
Skew	-1.08	0.26	-0.22	-1.45	0.32	-0.09	-1.20	-0.92	-0.09
Excess kurtosis	0.37	-0.69	1.30	2.61	-2.15	-1.26	1.39	0.49	-2.12
Equity correlation	0.97	0.41	0.60	0.91	0.07	0.68	0.90		
Equity Beta	0.47	0.06	0.12	0.34	0.05	0.17	0.31		
Fixed income correlation	0.30	0.39	0.70	0.29	0.13	0.69	0.36		
Fixed income beta	0.38	0.16	0.39	0.29	0.22	0.44	0.32		
Average fund data (years)	3.64	3.94	4.17	4.45	3.74	4.59	4.42		
Total number of funds	1,793	490	612	226	518	324	2,049		

Exhibit A.1: Select Subcategory Statistics / Liquid Alternatives (Equal-Weighted category averages)

Source: Vanguard calculations, based on data from Morningstar, Inc., and HFR

	Long/ short equity (ex-EMN)	Market neutral	Long/short credit	Event- driven	Managed futures	Currency	Multistrategy	FTSE Global All Cap Index	Bloomberg Barclays Global Aggregated Bond Index
Annualized return	5.37%	2.96%	5.38%	6.56%	5.09%	1.12%	3.45%	9.15%	3.68%
Standard Deviation	6.10%	2.55%	5.50%	5.95%	7.80%	3.08%	4.91%	14.95%	5.64%
Sharpe ratio	0.69	0.70	0.77	0.91	0.50	0.25	0.46	0.53	0.44
Skew	-1.01	-1.41	-2.36	-1.27	0.17	0.00	-1.45	-0.92	-0.09
Excess kurtosis	0.05	1.00	10.94	1.10	-2.89	-3.12	1.48	0.49	-2.12
Equity correlation	0.87	0.56	0.76	0.87	0.16	0.03	0.80		
Equity Beta	0.35	0.10	0.28	0.34	0.08	0.01	0.26		
Fixed income correlation	0.30	0.07	0.22	0.22	0.23	0.17	0.20		
Fixed income beta	0.32	0.03	0.22	0.23	0.30	0.09	0.17		
Average fund data (years)	8.75	4.45	5.36	6.12	5.62	4.99	6.30		
Total number of funds	1,391	804	472	1,288	1,037	334	3,080		

Exhibit A.2: Select Subcategory Statistics / Hedge Funds (HFRI indexes)

Notes: The exhibit presents statistics for hedge fund categories. We also ran the same analysis for liquid alternatives, which showed similar time-varying trends. Data cover July 2003 through June 2018. Because of data limitations, the time series for the currency category starts January 2008. Correlations and betas are calculated relative to the FTSE Global All Cap Index and the Bloomberg Barclays Global Aggregate Bond Index. Betas are calculated using excess returns over cash.

Appendix B: Regression Analysis

	Long/short equity (ex-EMN)	Market neutral	Long/short credit	Event-driven	Managed futures	Currency	Multistrategy
Alpha (annualized %)	0.80%	1.69%	2.05%	0.60%	3.96%	-0.20%	1.10%
	1.79	3.07	3.10	0.92	1.71	-0.27	2.08
Market beta	0.47	0.07	0.13	0.37	0.02	0.17	0.32
	54.27	6.18	9.85	28.37	0.40	13.21	30.85
Adjusted R ²	94.27%	17.22%	34.93%	81.78%	-0.47%	58.12%	84.16%

■ Statistically significant to 1%

■ Statistically significant to 5%

Exhibit B.a: Full Regression Analysis Output

1-factor (market) Gression of monthly liquid alternative excess returns (July 2003-June 2018)

	Long/short equity (ex-EMN)	Market neutral	Long/short credit	Event-driven	Managed futures	Currency	Multistrategy
Alpha (annualized %)	0.50%	1.24%	0.82%	-0.11%	1.96%	-0.89%	0.09%
	1.13	2.13	1.37	-0.18	0.86	-1.20	0.17
Market beta	0.44	0.06	0.06	0.30	0.29	0.14	0.29
	31.90	3.43	2.93	14.90	4.01	6.42	19.04
SMB beta	0.02	0.05	0.02	0.04	-0.05	0.06	0.09
	0.76	1.45	0.76	1.08	-0.38	1.29	3.33
HML beta	-0.04	0.02	0.06	0.00	0.00	0.04	-0.03
	-1.60	0.65	1.80	-0.02	0.04	1.24	-1.13
MOM beta	0.04	0.04	0.01	-0.02	0.21	-0.01	0.07
	3.08	2.35	0.42	-1.08	3.25	-0.58	5.20
Term beta	-0.02	0.04	0.21	0.10	0.11	0.11	0.08
	-0.99	1.44	7.85	3.39	1.07	3.17	3.68
Investment-grade credit beta	-0.10	0.09	0.07	-0.23	-0.14	-0.01	0.04
	-1.73	1.14	0.88	-2.78	-0.47	-0.16	0.56
High yield beta	0.12	-0.01	0.15	0.24	-0.38	0.06	0.09
	3.88	-0.21	3.53	5.19	-2.30	1.16	2.67
Adjusted R ²	95.03%	19.93%	53.75%	84.89%	16.40%	60.80%	88.36%

■ Statistically significant to 1%

■ Statistically significant to 5%

Exhibit B.b: 7-factor (market+size+value+momentum+term+credit+high yield)

Regressions of Monthly liquid alternative excess returns (July 2003-June 2018)

	Long/short equity (ex-EMN)	Market neutral	Long/short credit	Event-driven	Managed futures	Currency	Multistrategy
Alpha (annualized %)	0.68%	0.57%	0.86%	-0.09%	6.01%	-1.38%	0.85%
	1.14	0.75	1.13	-0.10	2.20	-1.43	1.47
Market beta	0.44	0.07	0.03	0.32	0.19	0.16	0.27
	24.05	3.18	1.27	12.01	2.20	5.58	14.92
SMB beta	0.02	0.03	-0.02	0.06	-0.17	0.07	0.01
	0.50	0.89	-0.60	1.42	-1.22	1.39	0.45
HML beta	-0.02	0.03	0.01	0.04	-0.17	0.04	-0.06
	-0.90	0.75	0.39	1.01	-1.38	1.00	-2.50
MOM beta	0.03	0.01	0.00	-0.01	0.25	-0.02	0.06
	2.38	0.76	-0.06	-0.37	3.80	-0.88	4.14
BAB beta	-0.01	0.08	0.11	-0.06	0.15	0.05	0.08
	-0.68	3.37	4.38	-2.31	1.62	1.53	4.39
QMJ beta	0.00	0.02	-0.10	0.07	-0.31	0.04	-0.13
	0.09	0.33	-2.06	1.32	-1.75	0.60	-3.45
Liquidity beta	0.03	-0.01	-0.03	0.00	-0.03	-0.01	0.03
	2.22	-0.38	-1.70	0.22	-0.61	-0.51	2.68
Bond trend beta	0.00	0.00	0.00	0.01	0.01	-0.01	0.00
	-0.04	0.62	-1.09	1.22	0.67	-1.31	-0.13
Currency trend beta	0.00	0.00	0.01	0.00	0.03	0.00	0.01
	1.06	1.42	2.09	0.90	2.89	0.93	2.55
Commodities trend beta	0.00	0.00	0.00	0.00	0.02	0.00	0.00
	-0.90	0.23	-0.23	-1.30	1.45	-0.46	0.05
Short rates trend beta	0.00	0.00	0.00	0.00	0.01	0.01	0.00
	-0.40	-0.68	0.60	-1.12	1.48	1.88	-1.04
Stock trend beta	0.00	0.00	0.00	0.00	0.03	0.00	0.01
	0.44	-0.47	0.96	-0.35	2.40	0.17	2.90
Term beta	-0.01	0.02	0.20	0.09	0.11	0.12	0.09
	-0.33	0.57	7.11	2.95	1.06	3.00	4.02
Investment-grade credit beta	-0.10	0.05	0.03	-0.19	0.01	-0.03	-0.02
	-1.72	0.70	0.33	-2.19	0.03	-0.36	-0.40
High yield beta	0.12	-0.02	0.16	0.25	-0.22	0.07	0.08
	3.48	-0.48	3.73	5.12	-1.38	1.35	2.39
Adjusted R ²	95.05%	23.48%	59.21%	85.64%	29.95%	61.60%	91.02%

- Statistically significant to 1%
- Statistically significant to 5%

Exhibit B.c: Custom Model
 Regressions of monthly liquid alternative excess returns (July 2003-December 2017)

	Long/short equity (ex-EMN)	Market neutral	Long/short credit	Event-driven	Managed futures	Currency	Multistrategy
Alpha (annualized %)	2.60%	2.44%	3.23%	3.93%	5.06%	2.58%	1.25%
	3.25	4.45	3.34	5.06	2.51	2.60	1.64
Market beta	0.36	0.10	0.29	0.36	0.08	0.00	0.27
	23.09	9.21	15.08	23.43	2.11	-0.04	18.18
Adjusted R ²	74.83%	31.91%	55.83%	75.38%	1.88%	-0.80%	64.79%

- Statistically significant to 1%
- Statistically significant to 5%

Exhibit B.d: 1-factor (Market)
Regressions of monthly hedge fund excess returns (July 2003-June 2018)

	Long/short equity (ex-EMN)	Market neutral	Long/short credit	Event-driven	Managed futures	Currency	Multistrategy
Alpha (annualized %)	2.49%	2.52%	2.69%	3.73%	2.25%	2.13%	0.85%
	3.38	5.21	3.87	5.81	1.16	2.02	1.35
Market beta	0.31	0.10	0.03	0.24	0.29	0.04	0.22
	13.51	6.92	1.43	11.92	4.69	1.34	11.19
SMB beta	0.20	0.02	0.07	0.22	0.10	0.06	0.16
	4.98	0.80	1.95	6.28	0.93	1.04	4.71
HML beta	-0.11	0.01	0.04	0.06	-0.03	-0.05	-0.08
	-2.82	0.47	1.03	1.98	-0.29	-1.07	-2.45
MOM beta	0.05	0.09	0.04	0.06	0.21	0.00	0.11
	2.63	6.70	2.17	3.43	3.78	-0.06	6.38
Term beta	-0.06	-0.08	0.07	-0.06	0.22	0.06	-0.04
	-1.76	-3.56	2.25	-2.03	2.54	1.34	-1.47
Investment-grade credit beta	0.16	0.32	0.38	0.24	-0.15	0.06	0.35
	1.71	5.05	4.19	2.92	-0.58	0.49	4.26
High yield beta	0.06	-0.12	0.40	0.14	-0.23	-0.10	0.01
	1.11	-3.39	7.92	2.95	-1.61	-1.36	0.13
Adjusted R ²	81.71%	54.51%	80.46%	85.53%	20.87%	1.24%	79.14%

- Statistically significant to 1%
- Statistically significant to 5%

Exhibit B.e: 7-factor (market+size+value+momentum+term+credit+high yield)
Regressions of monthly hedge fund excess returns (July 2003-June 2018)

	Long/short equity (ex-EMN)	Market neutral	Long/short credit	Event-driven	Managed futures	Currency	Multistrategy
Alpha (annualized %)	2.34%	2.70%	2.48%	4.42%	5.52%	2.17%	1.83%
	2.63	4.47	2.98	5.75	2.46	1.69	2.54
Market beta	0.30	0.09	0.00	0.19	0.23	0.05	0.17
	11.02	4.74	0.13	7.89	3.26	1.32	7.63
SMB beta	0.14	-0.02	-0.03	0.10	0.05	0.06	0.04
	3.22	-0.72	-0.67	2.66	0.43	0.89	1.07
HML beta	-0.09	0.01	0.02	0.04	-0.15	-0.08	-0.12
	-2.25	0.38	0.45	1.06	-1.49	-1.37	-3.81
MOM beta	0.02	0.08	0.01	0.05	0.24	0.01	0.09
	0.72	5.52	0.50	2.73	4.41	0.40	5.21
BAB beta	0.08	0.04	0.15	0.10	0.04	0.06	0.12
	2.66	2.08	5.61	4.02	0.51	1.22	5.24
QMJ beta	-0.08	-0.05	-0.16	-0.20	-0.13	0.00	-0.20
	-1.44	-1.33	-2.90	-3.98	-0.90	-0.04	-4.37
Liquidity beta	0.10	0.02	0.01	0.03	-0.01	-0.04	0.03
	5.37	1.59	0.62	1.64	-0.21	-1.25	2.20
Bond trend beta	-0.01	0.00	0.00	0.00	0.01	-0.01	0.00
	-1.38	-1.00	-0.22	-1.11	0.73	-1.23	-0.04
Currency trend beta	0.00	0.00	0.00	0.00	0.03	0.02	0.00
	0.79	0.71	-0.98	1.56	3.19	3.55	1.66
Commodities trend beta	0.00	-0.01	0.00	-0.01	0.03	0.00	0.00
	-0.94	-2.95	-1.27	-2.16	3.18	-0.74	-0.20
Short rates trend beta	0.00	0.00	0.00	0.00	0.00	0.01	-0.01
	0.25	-2.17	-2.31	-2.35	0.67	1.20	-3.51
Stock trend beta	0.01	0.00	0.00	0.01	0.03	0.01	0.01
	1.96	1.62	0.26	1.65	2.69	0.93	2.63
Term beta	0.00	-0.08	0.05	-0.06	0.24	0.08	-0.05
	-0.06	-3.47	1.57	-2.02	2.82	1.44	-1.74
Investment-grade credit beta	0.06	0.25	0.23	0.13	0.02	0.07	0.23
	0.66	4.05	2.67	1.67	0.11	0.54	3.06
High yield beta	0.01	-0.13	0.34	0.11	-0.06	-0.03	-0.02
	0.23	-3.78	7.02	2.44	-0.48	-0.38	-0.47
Adjusted R ²	85.00%	59.49%	84.52%	88.56%	38.21%	11.98%	84.74%

■ Statistically significant to 1%

■ Statistically significant to 5%

Exhibit B.f: Custom model
Regressions of monthly hedge fund excess returns (July 2003 - December 2017)

Definitions and Sources for Regression Analysis

Fama-French-Carhart

1. Market-Rf (market): The return on a region's value-weight market portfolio minus the 1-month U.S. Treasury bill rate.
2. SMB (size): The equal-weight average of the returns on the three small stock portfolios for a region minus the average of the returns on the three big stock portfolios.
3. HML (value): The equal-weight average of the returns for the two high (B/M) portfolios for a region minus the average of the returns for the two low B/M portfolios.
4. MOM (momentum): The equal-weight average of the returns for the two winner portfolios for a region minus the average of the returns for the two loser portfolios.

Data and additional detail for the above can be found at mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

AQR Capital Management

5. BAB (low volatility): Securities in a country are ranked in ascending order based on their estimated beta, and the ranked securities are assigned to one of two portfolios: low beta and high beta. The BAB factor is a self-financing zero beta portfolio consisting of the long low-beta and short high-beta portfolios.
6. QMJ (quality): Securities are assigned a quality score that is the average of profitability, growth, safety, and payout. The QMJ factor is the average return on two high-quality portfolios (sorted by size) minus the average return on two low-quality portfolios.

Data and additional detail for the above can be found at www.aqr.com/Insights/Datasets

Pastor-Stambaugh

7. LIQ (liquidity): The traded factor is the value-weighted return on the "10-1" portfolio from a sort on historical liquidity betas. The "10-1" spread goes long decile 10 (stocks with high-liquidity betas) and short decile 1 (stocks with low-liquidity betas).

Data and additional detail for the above can be found at faculty.chicagobooth.edu/lubos.pastor/research/.

Fung-Hsieh

8. Bond straddle (bond trend): The return on a portfolio of lookback straddles on bond futures.
9. Currency straddle (currency trend): The return on a portfolio of lookback straddles on currency futures.
10. Commodities straddle (commodities trend): The return on a portfolio of lookback straddles on commodities futures.
11. STIR straddle (short rates trend): The return on a portfolio of lookback straddles on short-term interest

12. Stock straddle (stock trend): The return on a portfolio of lookback straddles on stock futures.

- Fung and Hsieh (2001) identified that trend-following strategies can be modeled as portfolios of lookback straddles.
- A lookback straddle consists of a pair of lookback call and put options. A lookback option is a call/put option giving the holder the retroactive right to buy/sell the underlying asset at its minimum/maximum during the lookback period.
- Similar to option buyers, trend-following strategies make money when markets are volatile.

Data and additional detail for the above can be found at faculty.fuqua.duke.edu/~dah7/HFDData.htm.

Global active bond fund returns: A factor decomposition

13. Term: The Bloomberg Barclays Global Government Bond Index 10+ year total return (base currency-hedged) minus the 1-month Treasury bill total return. .
14. Investment-grade credit: The Bloomberg Barclays Global Aggregate Float Adjusted Index (base currency-hedged) corporate credit excess return. The corporate credit excess return is the corporate credit total return minus the duration-neutral Treasury total return.
15. High yield: The Bloomberg Barclays Global High Yield Bond Index (base currency-hedged) total return minus the Bloomberg Barclays Global Aggregate Bond Index (base currency-hedged) total return.

Endnotes

1. See Davis et al. (2018) for Vanguard's capital markets outlook.
2. Throughout this paper, we refer to the combined group of hedge funds and liquid alternatives as "alternative investment strategies."
3. The use of derivatives by '40 Act funds has been regulated under Section 18 of the act and through a series of no-action letters from the U.S. Securities and Exchange Commission. See Miller (2018) for more information. Hedge funds generally maintain similar margining requirements as with short-selling.
4. Various classification frameworks exist for alternative investment strategies in practitioner literature. For example, see Goldman Sachs Asset Management (2019). Academic literature often relies on classification structures provided by data sources such as Hedge Fund Research (HFR) or Credit Suisse/Tremont.

5. A large number of broadly accessible, commingled products does not currently exist. Replication products are a common way to gain access. For example, HFR Asset Management will build separate accounts to seek to track HFRX indexes (daily hedge fund index return streams). HFRX indexes follow a different construction methodology from HFRI indexes. Other replication products use regression analysis to estimate exposures to investable factors that have a high degree of correlation to categories of hedge fund strategies through indexes that publish category returns. These products then invest in these specific assets. See Kazemi, Black, and Chambers (2016) for more detail. Investors should be mindful that replication products may produce high tracking error and underperformance relative to the underlying index.
6. From a practitioner's perspective, building a diversified allocation of hedge funds outside of investing through a fund of funds or a replication product requires substantial portfolio assets, as fund investment minimums are often high (see Figure 1). In turn, for those planning to invest in one hedge fund or a small number of hedge funds, using individual fund characteristics may be a more representative starting point for assessing an allocation.
7. See Wallick et al. (2015) for more detail. The bottom-up portfolio construction process begins with manager selection.
8. See Fung and Hsieh (2004) for an additional perspective on hedge fund benchmarking. See Huguen and Eckrich (2015) for more detail on the challenges of liquid alternative benchmarking.
9. Biases and limitations with hedge fund data sets have been documented extensively in academic literature, often cited as influencing reported returns upward. The more common biases include selection bias, survivorship bias, and backfill bias. Other notable data limitations include relatively short data history and a lack of transparency into fund holdings. See Asness, Krail, and Liew (2001), Fung and Hsieh (2004), and Ennis and Sebastian (2003) for more discussion.
10. Returns are in excess of the 1-month U.S. Treasury bill rate. Hedge fund returns are reported to HFR net of all fees. We gross up returns using a similar methodology as in Bhardwaj (2010).
11. As discussed earlier, many hedge funds hold illiquid securities that are difficult to price continuously. Stale pricing for these securities (due to either illiquidity or managed pricing) can reduce estimates of volatility and correlation with traditional assets. In the presence of stale or managed prices, and outside of using longer-horizon returns, equity betas may be biased downward. Using lagged market returns to estimate beta captures the magnitude and statistical significance of this effect, providing a more accurate beta estimate. For example, Asness, Krail, and Liew (2001) find notable increases in (summed) equity betas when using lagged equity returns relative to the simple market model.
12. Although we have reliable net returns for our hedge fund and liquid alternatives data, we lack a reliable, systematic way to apply cost assumptions to our righthand-side variables required for a net-of-cost specification. Theoretically, analyzing net alphas rather than gross alphas would be a more practical way to assess the value-add that managers deliver to investors after fees are accounted for. Academic work provides some implementation cost assumptions we could have used as a starting point for a few of our risk factors, but we determined that this would introduce more noise into our alphas, and we opted to leave our excess returns and risk factors gross of cost to obtain a purer snapshot of performance.
13. See Hasanhodzic and Lo (2007) and Simonian and Wu (2019) for more detailed discussions of hedge fund replication.
14. See Agarwal, Boyson, and Naik (2009) and Hartley (2019).
15. Our linear regression models did not show great explanatory power for global macro substrategies (managed futures and currency). Nonlinear relationships may be present, or these categories may be difficult to explain with systematic risk factor exposures. Other regression model specifications might improve results, though this analysis is beyond the scope of our paper.
16. Institutional investors, for example, have many of these portfolio construction preferences and constraints documented in an investment policy statement.
17. Setting return, volatility, and correlation expectations is critical for the use of any strategy—regardless of investment objective—in a forward-looking portfolio construction exercise.
18. Some strategies may produce return distributions that are highly nonnormal (that is, with large negative skew and/or high excess kurtosis). In turn, other metrics that focus on downside volatility, such as the Sortino ratio, may be prudent to evaluate. See Philips (2006) for more discussion.
19. When we relaxed our 15-year data requirement to include funds with at least ten years of data history and reran the analysis in Exhibit 7, a larger percentage of efficient frontiers populated the area below the base-case scenario, particularly for liquid alternatives. Nonetheless, this is a reasonable way to highlight the variability in the portfolio construction process when examining individual managers.
20. More specifically, because we find that hedge funds outperform their liquid alternative peers on average, such analysis can lead investors to prefer a private vehicle over a public option based on inappropriate analysis.

21. Although this analysis essentially focuses on risk-return benefits as we use mean-variance optimization to assess how multistrategy funds improve an efficient frontier, this general conclusion holds true for various investment objectives that investors may target.
22. In a historical context, the optimization funding source will also be time-period-specific, as the risk-adjusted return profile and correlations of various asset/sub-asset classes change through time.
23. Correlation captures the directional co-movement of the strategy and global equity-fixed income, while beta captures the magnitude of that co-movement.

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Authors Bios'



Chris Tidmore, CFA, CPA
Vanguard Investment Strategy Group

Chris Tidmore, CFA, CPA, is a senior investment strategist in Vanguard Investment Strategy Group, where he leads the team that conducts research and provides thought leadership on issues related to active management. Before joining Vanguard, Chris managed an event-driven hedge fund, worked as an arbitrage trader and portfolio manager for a large family office, an options trader on the American Stock Exchange and was employed as an auditor and consultant.

Chris has developed and taught on a variety of financial and accounting topics, earned a B.S. in accounting at the University of Delaware and a past president of the CFA Society of Philadelphia.



Daniel B. Berkowitz, CFA
Vanguard Investment Strategy Group

At the time of publication Daniel Berkowitz was an investment analyst in Vanguard Investment Strategy Group. He covered a wide range of investment topics, with a specific focus on the use of active management in portfolio construction, including active/passive combinations, alternative investments, and factor-based investing.

Mr. Berkowitz joined Vanguard in 2014 through the Vanguard M.B.A. Development Program, rotating through Vanguard International, Institutional Advisory Services, and Investment Strategy Group. He officially joined the Investment Strategy Group in 2015.

Mr. Berkowitz earned both a B.S. and M.B.A. from Cornell University. He also is a CFA® charterholder and member of the CFA Society of Philadelphia.