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In pursuit of alpha: Evaluating active and passive strategies

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- We examine the gross and net alphas of active and index U.S. equity mutual funds and exchange-traded funds, both dead and alive, over the past 12 years on a four-factor-adjusted basis in order to empirically test the zero-sum-game theory.
- We find that the average fund does not generate positive gross alpha on either an equal-weighted or asset-weighted basis. The average fund generates negative net alpha on both an equal- and asset-weighted basis.
- Using multivariate regression, we find that higher portfolio turnover is associated with lower gross alphas and that there is no evidence of year-over-year persistence of outperformance among fund managers. Critically, we find that there is no difference in these findings between active and index funds, suggesting that fund characteristics are more important than the *active* and *index* labels.

A factor-based framework for estimating alpha

Consistent with the zero-sum-game theory outlined by Sharpe (1991), research finds that actively managed mutual funds, on average, underperform after accounting for expense ratios on both a factor-adjusted basis (Fama and French (2010)) and an excess-return basis (Harbron, Roberts, and Rowley (2017)). In particular, Carhart (1997), Financial Research Corporation (2002), and Kinnel (2010) find that expense ratio is the most accurate predictor of future performance for actively managed funds, while Elton, Gruber, and Busse (2004) and Rowley and Kwon (2015) note the inverse relationship between expense ratio and performance for index funds.

One method for gauging relative performance calculates the excess return of funds compared with a prospectus or style benchmark. Active managers, however, are not necessarily constrained by benchmarks. For example, Thatcher (2009) finds that large-capitalization active managers held mid- and small-cap stocks in their portfolios during times when those stocks outperformed to increase returns. This benchmark mismatch can make excess return a biased statistic of "alpha."

The growing familiarity with factors suggests another method of estimating a manager's relative performance.[1] By using factor exposures to estimate alpha, the challenge of benchmark mismatch is greatly reduced, and funds can be compared to one another regardless of investment strategy.

We assess the relative performance of U.S. equity mutual funds and exchange-traded funds (ETFs) in a factor-based framework. Our analysis uses a four-factor model consisting of market, size, value, and momentum, based on factors identified by Sharpe (1964), Banz (1981), Fama and French (1992), and Carhart (1997), respectively. Researchers have identified numerous other factors (which John Cochrane famously referred to as the "factor zoo"[2]), but we limit our analysis to these four because they have been extensively tested and are widely accepted. In part because we limit our analysis to these four factors, we also limit our analysis to U.S. equity funds.[3]

The remaining sections of our paper describe our data sample and methodology, review our estimates of annual gross and net alpha across several variables, and discuss a multivariate regression we conducted with all of our variables that help explain differences in alpha. The final section summarizes our findings.

Data and methodology

We begin with all U.S. open-ended equity funds, including conventional mutual funds and ETFs, both actively managed and indexed, in the Morningstar Direct database during the 15-year period ended December 31, 2015 (referred to as "funds" throughout this paper). We then remove any fund that does not have information for a given year for gross returns or for the following fund characteristics: expense ratio, portfolio turnover, or assets under management (AUM). Consistent with our thesis that costs are a primary driver of performance, we focus on these fund characteristics because they all are either fund costs or proxies for fund costs. We also remove all funds that are not categorized in the traditional "nine-box" categories over our sample period. We use data from Kenneth French's website for the size, value, and momentum factor returns and the risk-free (1-month Treasury bill) rate, and we use the returns of Vanguard's Spliced Total Stock Market Index[4] over the risk-free rate to create the market factor returns.

We then estimate monthly alphas for each fund in our sample. Following Carhart (1997), we calculate a fund's (i.e., fund "i") factor loadings over a 36-month period ended at month "t" by regressing the fund's monthly gross excess return (the return above the risk-free rate before accounting for expense ratio) on the four factors, discarding any fund share class that does not have 36 months of trailing history at month "t."[5]

1 See Pappas and Dickson (2015) for a discussion of factor-based investing.

2 John Cochrane referred to the "factor zoo" in his 2011 address to the American Finance Association.

3 Analysis of fixed income or non-U.S. equities would require the introduction of factors specifically related to fixed income (Fama and French, 1993) and regionally based non-U.S. equities (Fama and French, 2012; Griffin, 2002).

4 Vanguard's Spliced Total Stock Market Index is defined as the Dow Jones Wilshire 5000 Index through April 22, 2005, the MSCI US Broad Market Index through June 2, 2013, and the CRSP US Total Market Index thereafter. We chose to calculate the market factor return in this manner to make it representative of the return of the total U.S. equity market.

5 This helps control for any bias that might be introduced because of inconsistent sample sizes. It also standardizes our performance-based statistics.

Style-box investing in a factor world

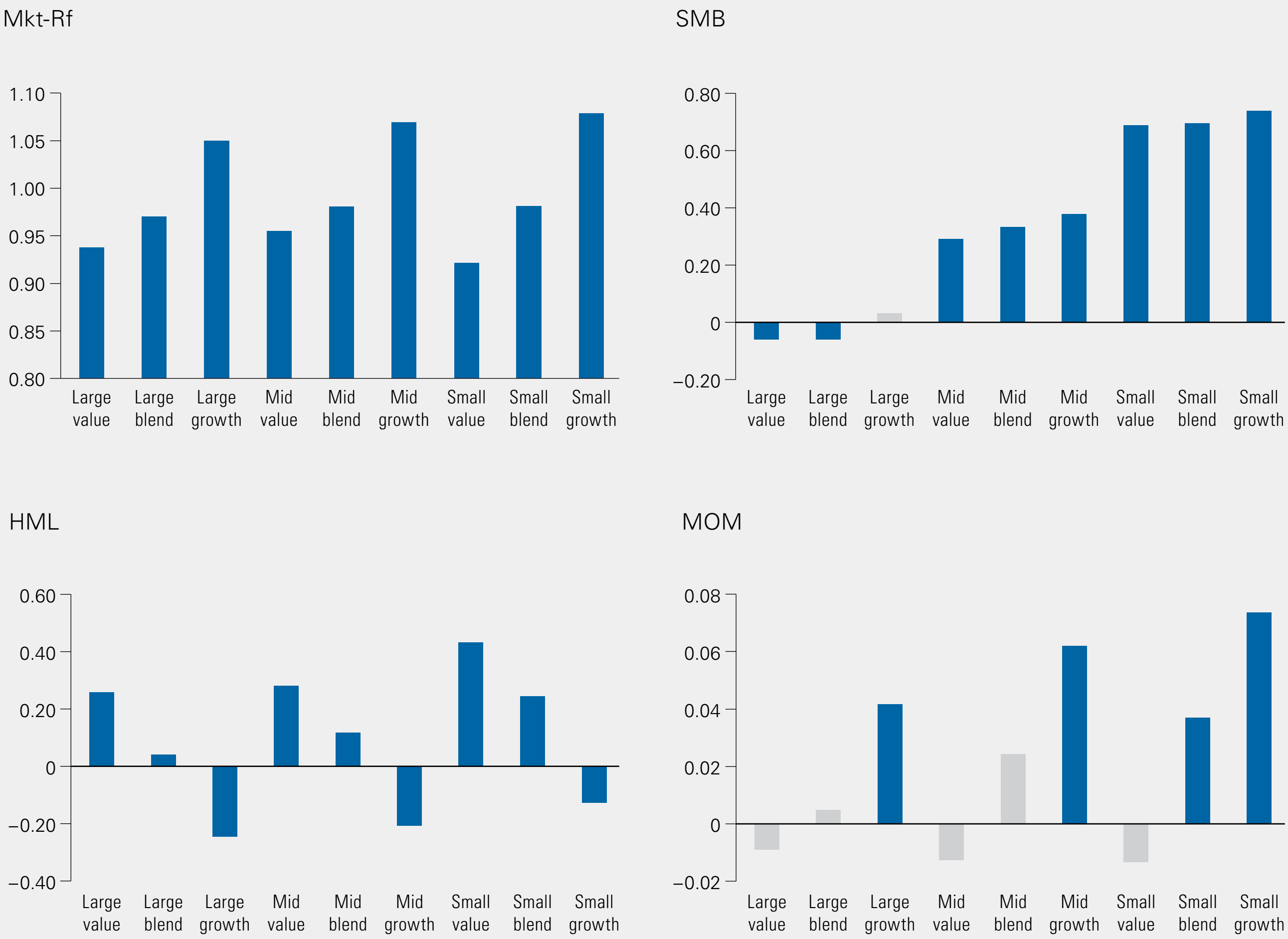
Although the term "factor investing" may be new to many investors, the practice has essentially been used for years through fund categories. Since its introduction in 1992, the traditional nine-box categorization has been the standard to help investors gauge exposures to U.S. equity size and style.

To test how well style-box classifications describe factor exposures, we conducted a regression of the time series of the style-box category monthly cross-sectional average fund excess return (relative to the risk-free rate) on four factors for the 15-year period ended December 31, 2015.

As one would expect, all categories possess a loading close to 1 on the market factor (Mkt-Rf), while mid- and small-cap funds load more heavily toward the size factor (SMB). Value funds load more heavily on the value factor (HML), and growth funds are weighted more on the momentum factor (MOM).

From this, we conclude that style-box classifications reasonably reflect market, size, value, and momentum factor exposures.

Style-box classification



Note: Blue bars indicate that values are statistically significant to at least 5%.

Source: Vanguard calculations based on data from Morningstar and Kenneth French's website, http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Next, we estimate the fund's one-month gross alpha at month t+1 using factor loadings from the regression over the 36 months ended at month "t," using the following equation:

$$\alpha_{it+1} = R_{it+1} - R_{ft+1} - \hat{b}_{it}(R_{mt+1} - R_{ft+1}) - \hat{s}_{it}SMB_{t+1} - \hat{h}_{it}HML_{t+1} - \hat{m}_{it}MOM_{t+1}$$

Where

α_{it+1} = one-month gross alpha at month t+1

$R_{it+1} - R_{ft+1}$ = one-month gross excess return at month t+1

$\hat{b}$, $\hat{s}$, $\hat{h}$, $\hat{m}$ equal factor loadings for market, size, value, and momentum, respectively, from 36-months ended at month t

$(R_{mt+1} - R_{ft+1})$, SMB_{t+1}, HML_{t+1}, MOM_{t+1} = factor returns for market, size, value, and momentum, respectively, at month t+1.

Put another way, we subtract each of the products of a factor loading and its relevant factor return from the actual one-month gross excess return (gross return shown in Morningstar less the risk-free rate), in order to estimate monthly gross alpha. We then sum the fund's estimated monthly gross alphas for all 12 months in a calendar year to generate an estimated annual gross alpha. Finally, we subtract the fund's annual expense ratio[6] from its estimated annual gross alpha to arrive at the fund's estimated annual net alpha.[7] This produces a sample of 22,716 fund-year observations, consisting of 2,641 index fund-year observations and 20,075 active fund-year observations.

It is worth reinforcing that we focus on estimating "alpha," the performance attributable to security selection and, to some extent, factor timing. Our analysis does not contemplate the strategic nature of a fund's factor exposures and how such exposures affect a fund's total return or excess return versus its prospectus benchmark.

The zero-sum-game effect

Assessing whether funds as a group produce nonzero estimated annual gross alpha is important. Because funds are a sub-sample of the full zero-sum-game universe, if funds as a whole generate positive (negative) gross alpha, it would suggest that other groups of investors—separate accounts, hedge funds, individual security holders, etc.—generate negative (positive) gross alpha.[8]

In response to the commonly raised objection that the practice of equal-weighting funds in studies understates the ability of fund managers to generate alpha, we enhance our analysis by measuring estimated annual alphas on both an equal-weighted and asset-weighted basis. This objection states that because there are a large number of relatively small funds that consistently underperform, these small funds, when measured on an equal-weighted basis, drag down the performance of the industry as a whole. On an asset-weighted basis, however, these funds would get a smaller weighting, and the result would be a more accurate reflection of the "average fund investor." This argument contrasts with Fama and French (2010), which found that funds' four-factor adjusted gross alpha was indistinguishable from zero and that net alpha was negative, regardless of the weighting method used.

When alphas offset

Figures 1a and **1b** show that although there are variations from year to year, median estimated annual gross alphas appear to be approximately zero, while estimated annual net alphas appear to be negative, consistent with principles of the zero-sum-game theory.

One observation of note is the wide dispersion of estimated alphas. This underscores the risk inherent in active management, because the large positive alpha produced by some managers is offset by the large negative alpha produced by others. For example, in 2008 fund estimated net alphas ranged from approximately –20% to 10%—a dispersion of approximately 30 percentage points. That year in particular calls into question the argument that active managers can protect their clients in bear markets, especially because the alphas shown are *after* adjusting for the significant negative performance of the market factor.

6 We calculate an asset-weighted expense ratio across a fund's share classes to represent the fund observation expense ratio. Ultimately, all of our fund observations are at the unique fund level. In addition, we removed observations that possessed either a negative expense ratio or an expense ratio greater than 3%. This amounted to 29 funds, roughly 0.72% of our eventual sample.

7 As an additional test, we also calculate estimated annual net alpha by dividing (1 + estimated annual gross alpha) by (1 + fund's annual expense ratio). Our overall results are substantially similar.

8 Fama and French (2010) notes the concept of "equilibrium accounting," stating that if active mutual funds have positive alpha before costs, active investments outside of mutual funds must have negative alpha before costs.

Figure 1a. Equal-weighted gross alpha by year is centered on zero

Estimated annual gross alpha

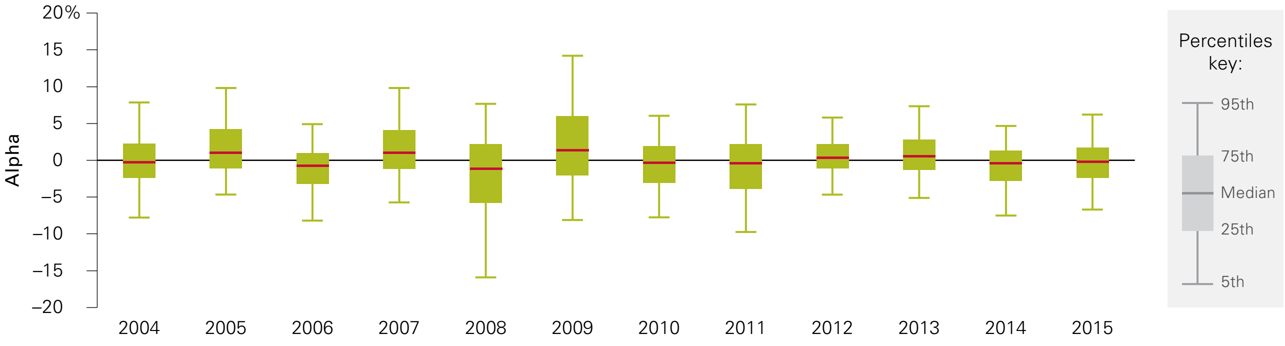
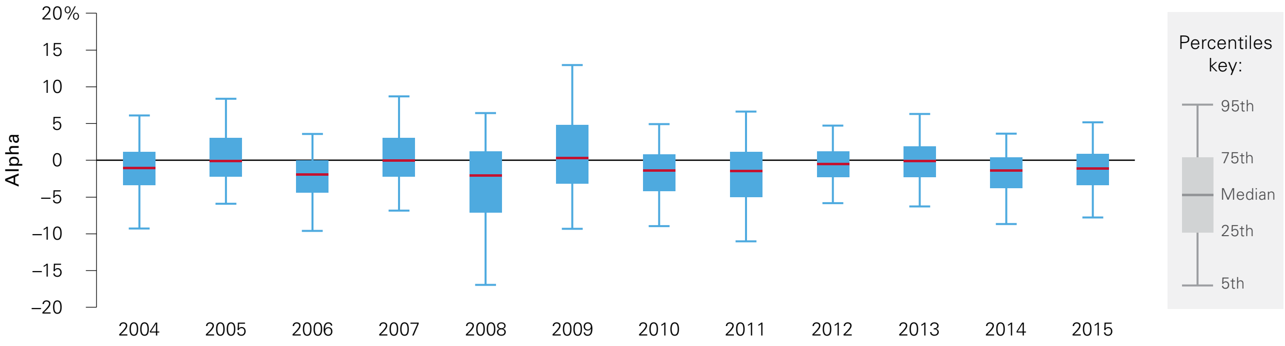


Figure 1b. Equal-weighted net alpha by year tends to be negative

Estimated annual net alpha



Source: Vanguard calculations based on data from Morningstar and Kenneth French's website.

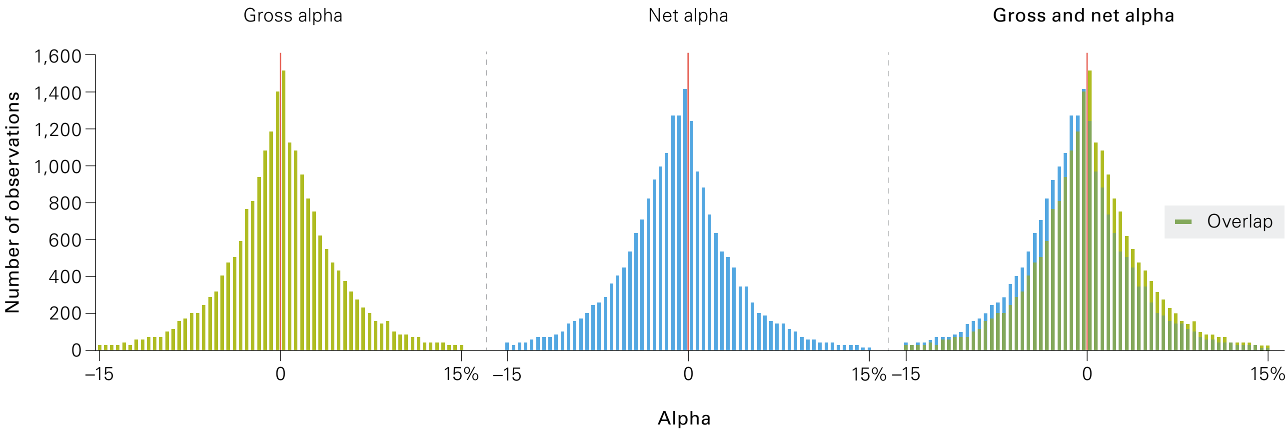
Putting the theory to the test

If the zero-sum-game theory applies to funds in a four-factor world, we would expect to see the distribution of estimated annual gross alphas be centered on a value of zero and the distribution of estimated annual net alphas have a central tendency that is less than zero, regardless of the time period chosen (Sharpe, 1991). **Figure 2** shows a histogram of the estimated annual gross (green) and net (blue) alphas from the funds in our sample. Estimated annual gross alphas are distributed around a mean value of 0.045%, which, with a t-statistic of 1.33, is indistinguishable from zero.[9] Estimated annual net alphas have a mean value of –1.03%, statistically significant at the 1% level. Given that the average expense ratio in our sample is 1.08%, this suggests an inverse one-to-one relationship between estimated annual net alpha and expense ratio. Based on our findings that average estimated annual gross alpha is approximately zero and that average estimated net alpha is negative by roughly the amount suggested by expense ratio, we conclude that the zero-sum-game theory accurately describes the four-factor adjusted alphas of U.S. equity funds on an equal-weighted basis.

Different weighting styles, consistent results

We also test to what extent zero-sum-game theory applies on an asset-weighted basis. To do this, we weight our estimated annual alphas by the previous calendar-year-end AUM. **Figures 3a** and **3b** show asset-weighted average estimated annual gross and net alphas, respectively, and their equal-weighted values for comparison. We find that on an asset-weighted basis, estimated annual gross alpha is inconsistent. Some years have a more favorable outcome for fund managers, some less favorable. However, estimated annual gross alpha seems to be approximately zero overall. More important, however, Figures 3a and 3b show that over the 12-year period we studied, the way funds are weighted does not change the results. On average, funds generate near-zero alpha on a gross basis and negative alpha on a net basis.

Figure 2. The zero-sum game holds empirically



	Mean (%)	Median (%)	t-stat	p-value	Standard deviation	Observations
Gross alpha	0.045	0.053	1.33	0.18	5.11	22,716
Net alpha	–1.032	–0.866	–30.31	0.00	5.13	22,716

Notes: The overlapping time periods utilized in our study could understate the standard errors, resulting in abnormally large t-statistics. However, this does not change the estimated coefficients, and we do not believe it changes the significance of the results. The largest 0.5% and smallest 0.5% of observations have been removed for visual acuity.

Source: Vanguard calculations based on data from Morningstar and Kenneth French's website.

9 If gross alpha is in fact zero, it suggests that funds are able to overcome the negative effects of transaction costs. For the full samples of gross and net alpha, both the skewness-kurtosis and the Shapiro-Wilk tests reject the null hypothesis that they are normally distributed.

Figure 3a. Gross alpha is cyclical but near zero over the long term on an equal- and asset-weighted basis

a. Estimated annual gross alpha

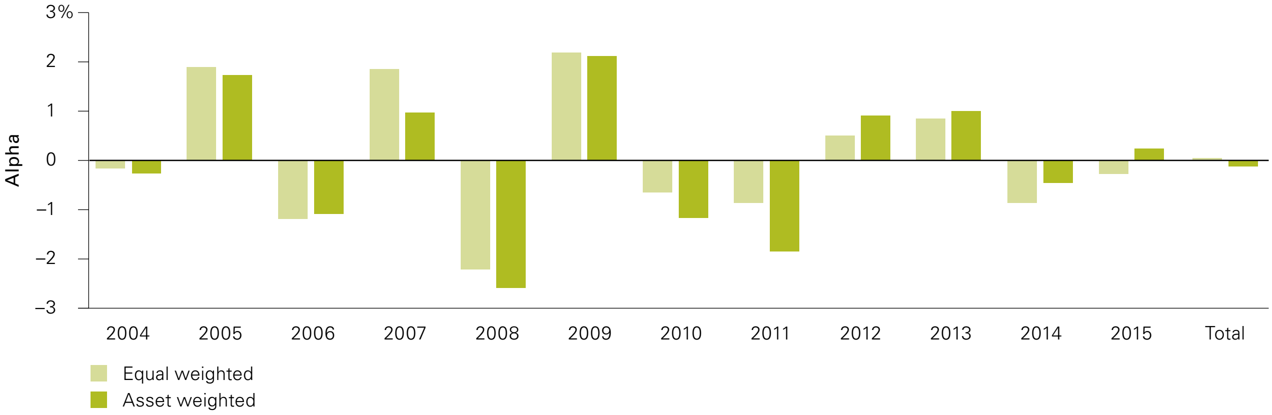
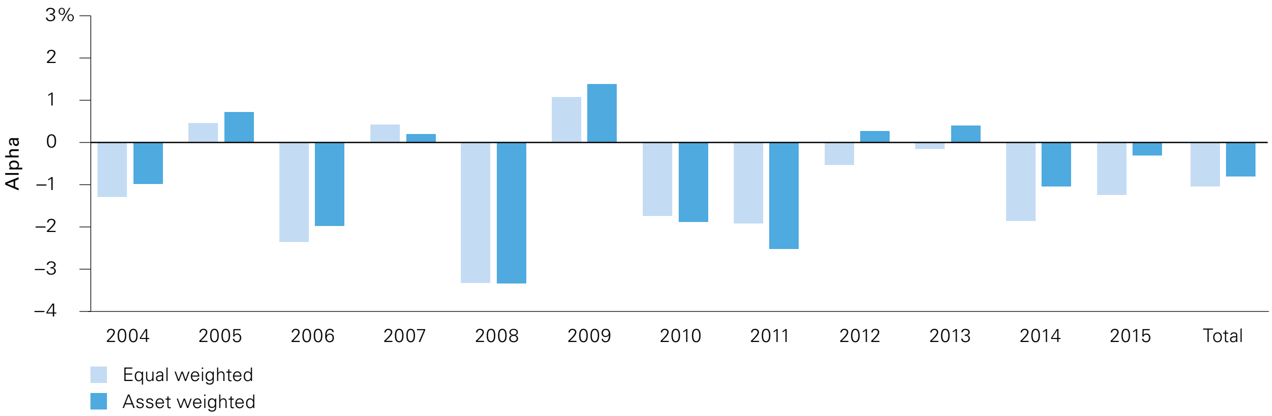


Figure 3b. Net alpha is negative on an equal- and asset-weighted basis

b. Estimated annual net alpha



Notes: For equal-weighted estimated annual alphas, "total" reflects the mean of all observations in the sample. For asset-weighted estimated annual alphas, "total" reflects the weighted average of all calendar year asset-weighted averages, where weighting is determined by the sample's AUM in a given year relative to the AUM for all of the other years (i.e., a weighted average of the weighted averages).

Source: Vanguard calculations based on data from Morningstar and Kenneth French's website.

The effect of independent variables on alpha

Because our findings suggest that the zero-sum-game theory holds empirically for both asset- and equal-weighted alphas, we test several independent variables to see how well they explain the variance of alpha. We identify expense ratio, portfolio turnover, and AUM as key independent variables. In this analysis, our portfolio turnover variable ("log turnover") is measured as the natural logarithm of a fund's portfolio turnover in order to linearize the relationship between alpha and a fund's portfolio turnover. AUM is measured as each fund's share of assets as of the previous calendar year-end divided by the total assets measured at the same point in time—they are the weights used to calculate asset-weighted performance statistics. This helps to mitigate autocorrelation concerns regarding year-over-year AUM growth and therefore characterizes AUM as a measure of relative size.

To gain a preliminary understanding of whether any relationships exist between estimated alpha and our key variables, we place the gross and net alphas into quintiles, sorted independently on expense ratio, log turnover, and AUM. **Figure 4** shows the results. (Quintile 1 represents low values for the independent variables, and Quintile 5 represents high values.)

Expense ratio appears to have a clear negative relationship with estimated annual net alpha because net alpha consistently decreases as expense ratio increases. However, it does not appear to have a formal relationship with estimated annual gross alpha. This is not surprising if one assumes that managers seek to maximize the returns of their funds regardless of their funds' expense ratio, and that, at the margin, higher expense ratios do not equate to additional returns. However, as noted by Wallick (2015), this does call into question the mantra of some high-cost managers that investors "get what they pay for" when it comes to expense ratios.

For log turnover, we see a monotonic pattern of estimated annual gross and net alpha decreasing as turnover increases. This is not necessarily surprising, because trading costs are not included in a fund's expense ratio, but they are reflected in the fund's returns, impacting both gross and net returns. Since turnover incurs costs for the fund in the form of commissions, bid-ask spreads, and market impact,

Figure 4. Estimated alphas sorted on variable

	Expense ratio		Log turnover		AUM	
Quintile	Gross	Net	Gross	Net	Gross	Net
1	0.09	–0.35	0.35	–0.49	0.01	–1.31
2	0.08	–0.82	0.30	–0.74	0.10	–1.04
3	–0.12	–1.22	0.20	–0.92	0.07	–1.03
4	0.04	–1.24	–0.10	–1.25	0.10	–0.91
5	0.13	–1.56	–0.53	–1.78	0.05	–0.87

Note: Alphas are measured in percentage points and represent the median value in a given quintile.
Source: Vanguard calculations based on data from Morningstar and Kenneth French's website.

we would expect higher turnover to be associated with lower alpha. This expectation is in contrast to claims that increased turnover results in higher alphas because managers with high turnover are consistently trading underperforming stocks for those that outperform. If this were the case, we would expect to see a positive relationship between turnover and gross alpha. Figure 4 suggests, however, that higher turnover is associated with lower gross (and net) alpha.

Conventional wisdom is divided on AUM's impact on fund performance. One argument is that fund performance improves with AUM as larger fund companies are able to bring more resources and economies of scale to bear, both increasing returns and lowering costs. The flip side of the argument states that AUM detracts from performance because as fund size increases, trades become crowded, decreasing the opportunity for alpha. Figure 4 suggests that no clear pattern emerges for AUM. Gross alpha seems to have a non-monotonic, inverse relationship with AUM, while net alpha appears to have a positive relationship with AUM.

We assessed the correlations among the three independent variables as a test of multicollinearity. If our independent variables are strongly correlated with one another, it could bias the relationship that these variables have on alpha. **Figure 5** indicates that some level of multicollinearity could at least partially explain some of the relationships we see in Figure 4. For example, some of the relationship between turnover and alpha could be because of some level of correlation between turnover and expense ratio. However, the relationship between turnover and expense ratio could be attributed to the characteristics of index funds and active funds, because index funds have lower log turnover (2.92 versus 3.97) and expense ratio (0.46% versus 1.16%) relative to active funds in our sample. We control for this difference in our regressions; therefore, we do not believe multicollinearity is a concern.

Figure 5. Correlation matrix

	Expense ratio	Log turnover	AUM
Expense ratio	1.00		
Log turnover	0.35	1.00	
AUM	–0.20	–0.16	1.00

Source: Vanguard calculations based on data from Morningstar and Kenneth French's website.

Examining the roles of fund category and fund strategy

Having examined our key independent variables, we turn to our categorical variables: fund category and fund strategy. We examine fund category to test the oft-repeated claim that actively managed funds perform better in markets considered less efficient, such as small-cap equities, than in those widely regarded as efficient, such as large-cap equities. We also examine fund strategy (i.e., whether a fund is an actively managed or index fund) to test whether active returns differ from those of indexed returns. **Figures 6** and **7** show the results of these tests.

Figure 6. Gross and net alpha by Morningstar category

Average estimated **annual gross alpha** by Morningstar category

Average estimated **annual net alpha** by Morningstar category

All funds

Annual gross alpha:

		Value	Blend	Growth
Large cap	x̄	–0.06	–0.21	–0.10
	t	–0.86	–3.97	–1.19
Mid cap	x̄	0.29	–0.10	0.32
	t	1.87	–0.76	2.35
Small cap	x̄	0.70	0.10	0.30
	t	4.15	0.91	2.30

Annual net alpha:

		Value	Blend	Growth
Large cap	x̄	–1.05	–1.11	–1.18
	t	–15.47	–20.64	–14.29
Mid cap	x̄	–0.80	–1.17	–0.90
	t	–5.20	–8.86	–6.66
Small cap	x̄	–0.49	–1.01	–1.00
	t	–2.94	–8.70	–7.61

Index funds

Annual gross alpha:

		Value	Blend	Growth
Large cap	x̄	0.94	–0.02	0.95
	t	3.64	–0.44	4.40
Mid cap	x̄	0.83	0.08	–0.94
	t	1.76	0.51	–2.03
Small cap	x̄	0.42	0.28	1.16
	t	1.03	1.85	3.06

Annual net alpha:

		Value	Blend	Growth
Large cap	x̄	0.52	–0.38	0.35
	t	1.97	–8.97	1.62
Mid cap	x̄	0.22	–0.35	–1.57
	t	0.47	–2.12	–3.42
Small cap	x̄	–0.18	–0.24	0.60
	t	–0.43	–1.54	1.60

Active funds

Annual gross alpha:

		Value	Blend	Growth
Large cap	x̄	–0.14	–0.26	–0.17
	t	–2.03	–3.95	–1.98
Mid cap	x̄	0.22	–0.15	0.39
	t	1.38	–0.94	2.74
Small cap	x̄	0.73	0.07	0.26
	t	4.02	0.54	1.95

Annual net alpha:

		Value	Blend	Growth
Large cap	x̄	–1.19	–1.31	–1.29
	t	–16.92	–19.51	–14.82
Mid cap	x̄	–0.92	–1.40	–0.87
	t	–5.67	–8.65	–6.16
Small cap	x̄	–0.53	–1.15	–1.07
	t	–2.93	–8.58	–7.86

Significant at 1%
Significant at 5%
Not significant

x̄ = Mean
t = t-statistic

Notes: The top number in each cell indicates the calculated average alpha in percentage point terms; the bottom number is the t-statistic for the estimated alpha.
Source: Vanguard calculations based on data from Morningstar and Kenneth French's website.

With respect to all funds, five categories have estimated annual gross alphas that are statistically indistinguishable from zero. Mid-cap growth, small-cap growth, and small-cap value funds exhibit positive estimated annual gross alpha to at least 5%, seemingly giving some credence to the idea that smaller-cap fund managers generate gross alpha. However, alpha is, on average, more than offset by the expense ratios of these funds. All estimated annual net alphas are negative at the 1% level.

In general, gross alpha does not seem to exhibit any clear trend across fund strategy; however, both index and active funds show non-negative estimated gross alpha in the small-cap space. Active funds in the small-cap value and mid-cap growth categories exhibit positive alpha to 1% significance, suggesting that an investor could capture positive net alpha if investment management costs were kept low enough. For example, an investor who was able to obtain "institutional pricing" of a small-cap value fund could capture positive alpha, as long as such pricing remained under 0.73%.

Comparing estimated annual net alphas of index funds and actively managed funds, index funds generally show estimated annual net alphas that are slightly negative or statistically indistinguishable from zero. Active funds, however, show statistically significant negative estimated annual net alphas in all nine Morningstar categories. This underscores the importance of managing costs.

Figure 7 displays estimated average annual alphas according to fund strategy. Gross alpha for active funds is statistically indistinguishable from zero, while net alphas for both index funds and active funds are negative and statistically significant. Active funds, however, show statistically significant lower net alpha than index funds by roughly the difference of their expense ratios.

Surprisingly, the index funds in our sample showed statistically significant gross alpha of 0.28%. Income earned through securities lending may explain part of this. Rowley, Kahler, and Schlanger (2016) found that the index funds in their sample augmented their annual returns by between 2.31 and 6.99 basis points on an asset-weighted average basis. In addition, Dunham and Simpson (2010) found evidence that S&P 500 Index funds add return by trading opportunistically around index changes. These two potential sources of return, however, still leave a large amount of our alpha unaccounted for. It could also be the case that some degree of factor misspecification may be responsible for the unexplained alpha among index funds.

Testing the relationship between variables

We conduct pooled multivariate regression analysis to examine the relationship between the independent variables expense ratio, log turnover, and AUM and the dependent variable estimated annual gross alpha. In addition, we include a dummy variable to indicate whether the fund is an active fund (1= active, 0=index). The regression is summarized as:

$$\text{Gross alpha}_{it} = \alpha + \beta_1(\text{Expense ratio}_{it}) + \beta_2(\text{Log turnover}_{it}) + \beta_3(\text{AUM}_{it}) + \beta_3(\text{Active indicator}_{it}) + \beta_4\Upsilon_t + + \beta_5\theta_i + \varepsilon_{it}$$

Where Υ_t represents yearly time effects (2015 is the base year) and θ_i represents Morningstar category fixed effects (large-cap blend is the base category).

Figure 7. Gross and net alphas by investment strategy

a. Estimated annual gross alpha

Strategy	Mean	t-stat	p-value	Standard deviation	Observations
Index	0.28%	4.70	0.00	3.09%	2,641
Active	0.01%	0.37	0.71	5.32%	20,075
Difference	0.27%	3.79	0.00		

b. Estimated annual net alpha

Strategy	Mean	t-stat	p-value	Standard deviation	Observations
Index	–0.18%	–2.95	0.00	3.10%	2,641
Active	–1.14%	–30.41	0.00	5.33%	20,075
Difference	0.97%	13.57	0.00		

Source: Vanguard calculations based on data from Morningstar and Kenneth French's website.

We conduct a second regression that adds two variables to test for evidence of persistent performance year over year: lagged alpha (the previous year's gross alpha) and lagged active interaction (the previous year's gross alpha given the fund is an actively managed fund).

Figure 8 shows the results for both regressions. Portfolio turnover is the dominant independent variable given its statistical significance and magnitude in both regressions. Neither expense ratio nor active indicator is significant. Although the AUM coefficient appears strong and statistically significant, its marginal effect on gross alpha is unclear. The adjusted R-square for regression 1 is 7.0% and for regression 2 is 7.6%; this means that although our models provide significant explanatory power, much of the variance is unexplained. Full regression results are located in the Appendix.

In the first regression, log turnover has a coefficient of –0.36, statistically significant to the 1% level. This finding suggests that funds incur costs through increased portfolio trading; it is consistent with Carhart's (1997) finding that turnover is negatively associated with abnormal return. The coefficient for expense ratio is indistinguishable from zero, meaning higher expense ratios are not associated with higher gross alphas. Stated another way, "premium pricing" does not lead to premium performance.[10] The AUM coefficient of –0.22 is negative and statistically significant to 5%, though its economic significance is small: The contribution to gross alpha by the AUM variable mean of 0.053 (which equates to a fund with approximately $1.9 billion in AUM) is –1.2 basis points (–0.22 multiplied by 0.053). In addition, the difference in gross alpha for a fund with 25th percentile AUM and 75th percentile AUM is –0.65 basis points (i.e. 0.0065%), all else equal. In the Appendix, we present the differential effects of expense ratio, log turnover, and AUM between the 75th and 25th percentiles of each variable.

Finally, the coefficient for the active indicator is not statistically significant, suggesting that after accounting for characteristics such as expense ratio and turnover (as well as for calendar year and fund category), there is no difference in estimated gross alpha between active and index funds. However, investors should be aware that active funds have greater variance around the average—as noted by standard deviation in Figure 7—meaning that active funds typically have less certainty regarding the amount of gross alpha, which should also mean less certainty regarding net returns.

In the second regression, the log turnover coefficient is a similar –0.38 (still significant at the 1% level), while expense ratio and active indicator remain indistinguishable from zero. The coefficient on AUM is –0.31 and statistically significant to 1%. Again, the economic significance is small. The contribution to gross alpha by the AUM variable mean is a mere –1.6 basis points, all else equal. Additionally, the difference in gross alpha between the 25th and 75th percentiles of AUM is still only –0.91 basis points, all else equal.[11]

The second regression also includes our tests of persistence. If fund managers are able to consistently generate year-over-year positive gross alpha, we would expect lagged alpha to be positive and statistically significant (i.e., last year's outperformers have a propensity to be this year's outperformers). In particular, if active managers exhibit persistent alpha, we would expect the lagged active interaction variable to be positive and statistically significant. The coefficients for both are

Figure 8. Log turnover is the dominant explanatory variable of gross alpha

	Expense ratio	Log turnover	AUM	Active indicator	Lagged gross alpha	Lagged gross alpha x active indicator
Without lag	0.11	–0.36**	–0.22*	–0.19		
With lag	0.02	–0.38**	–0.31**	–0.17	0.00	–0.05

Notes: Values in table represent regression coefficients for respective variables in main regression equations. One star indicates significance at the 5% level; two stars indicate significance at the 1% level. In unpublished results, we conduct similar regressions with estimated annual net alpha as the dependent variable. The major difference is that expense ratio is significantly and negatively associated with net alpha. The relationships of the other variables are substantially similar.

Source: Vanguard calculations based on data from Morningstar and Kenneth French's website.

10 In other regressions (not shown), we used the advisor fee reported for each fund in Morningstar and found that although the coefficient was negative, it was not significant at the 5% level.

11 In other regressions (not shown), we weighted each observation by the fund-year weight (our AUM variable), performing weighted least-squares estimation. The coefficients on expense ratio became negative and the coefficients on the active indicator became positive, but both were insignificant at 10%. Log turnover's coefficients increased in magnitude, so we concluded that our primary regression results were robust to alternative estimation methods.

indistinguishable from zero. As such, we find no evidence that the previous year's estimated annual gross alpha is a predictor of this year's estimated annual gross alpha.

In addition to the tests of our primary independent variables, we also included in our regression control variables for year (2015 is the base year) and fund category (large-cap blend is the base category). Our control variables largely confirmed what our initial examination of the data found: that alphas by year are inconsistent, with funds performing better in some years than in others but with overall gross alpha being approximately zero; and that small- and mid-cap funds are able to generate greater gross alpha compared with large-cap blend funds, but this additional alpha is not sufficient to overcome these funds' higher expense ratios.

Conclusion

We find that the average gross alpha for U.S. equity funds and ETFs is roughly zero on an equal-weighted and asset-weighted basis but that average net alpha is negative on both an equal-weighted and asset-weighted basis. Conducting multivariate regression, we find that expense ratios have no relationship to gross alpha, that higher portfolio turnover is associated with lower gross alpha, and that prior year gross alpha is not an indicator of current year gross alpha. From the standpoint of investment strategy and portfolio construction, however, a critical finding is that these effects apply to all funds—both actively managed and indexed.

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Appendix

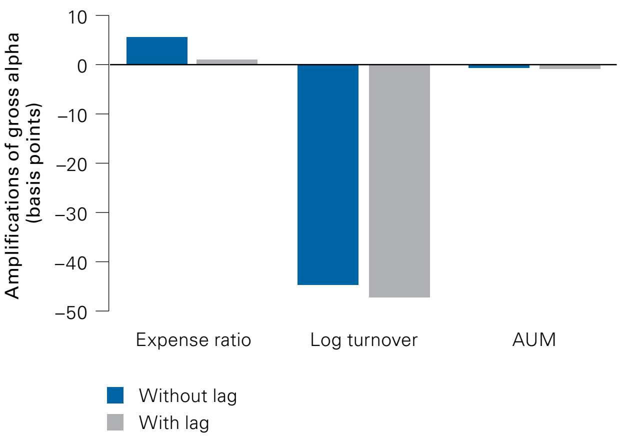
Summary statistics

These tables present the summary statistics and regression analysis of our compiled fund-year-observation data set discussed above.

	Gross alpha	Net alpha	Expense ratio	Log turnover	AUM
Mean	0.05	–1.03	1.08	3.85	0.05
Median	0.05	–0.87	1.09	3.99	0.01
Standard deviation	5.11	5.13	0.44	1.03	0.22
Number of observations	22,716	22,716	22,716	22,716	22,716

Note: Gross alpha, net alpha, and AUM are stated in percentage point terms.
Source: Vanguard calculations based on data from Morningstar and Kenneth French's website.

Differential effects of expense ratio, log turnover, and AUM



Notes: The chart shows amplification of gross alpha with and without the lagged gross alpha term in the regression. We account for year time effects, category fixed effects, and all independent variables. Amplification captures change in gross alpha given a specific change in one of the independent variables, while holding all other variables constant at their mean value. For these three variables, the change is represented by movement in a variable's value from the first quartile to the third quartile. For example, gross alpha (without lag) decreases from 24.4 basis points to –20.2 basis points—an amplification of –44.6—when turnover increased from 27% to 94%. In contrast, amplification of gross alpha for movement in AUM from the 25th percentile to the 75th percentile is –0.65 basis points, suggesting weak economic significance.
Source: Vanguard calculations based on data from Morningstar and Kenneth French's website.

Regression table

		Without lagged gross alpha	With lagged gross alpha
Expense ratio	β	0.11	0.02
	s	0.10	0.11
	t	1.09	0.18
	p	0.27	0.86
Log turnover	β	–0.36	–0.38
	s	0.04	0.04
	t	–9.31	–8.98
	p	0.00	0.00
AUM	β	–0.22	–0.31
	s	0.09	0.10
	t	–2.33	–3.03
	p	0.02	0.00
Active indicator	β	–0.19	–0.17
	s	0.10	0.11
	t	–1.79	–1.52
	p	0.07	0.13
Lagged gross alpha	β		0.00
	s		0.04
	t		0.02
	p		0.98
Lagged gross alpha*active	β		–0.05
	s		0.04
	t		–1.26
	p		0.21
Large growth	β	0.35	0.27
	s	0.10	0.10
	t	3.65	2.65
	p	0.00	0.01

		Without lagged gross alpha	With lagged gross alpha
Large value	β	0.25	0.24
	s	0.09	0.10
	t	2.67	2.38
	p	0.01	0.02
Mid blend	β	0.24	–0.02
	s	0.14	0.15
	t	1.73	–0.14
	p	0.08	0.89
Mid growth	β	0.79	0.56
	s	0.14	0.15
	t	5.76	3.81
	p	0.00	0.00
Mid value	β	0.69	0.64
	s	0.17	0.19
	t	4.08	3.44
	p	0.00	0.00
Small blend	β	0.46	0.52
	s	0.13	0.14
	t	3.57	3.76
	p	0.00	0.00
Small growth	β	0.81	0.94
	s	0.14	0.15
	t	5.86	6.32
	p	0.00	0.00
Small value	β	1.08	1.08
	s	0.18	0.20
	t	5.86	5.43
	p	0.00	0.00

Variable key
β = coefficient
s = standard error
t = t-statistic
p = p-value

(Continued on last page)

Regression table *(Continued).*

		Without lagged gross alpha	With lagged gross alpha
2004	β	0.12	
	s	0.18	
	t	0.67	
	p	0.50	
2005	β	1.99	2.29
	s	0.14	0.18
	t	14.60	12.68
	p	0.00	0.00
2006	β	–0.83	–0.69
	s	0.13	0.14
	t	–6.51	–5.04
	p	0.00	0.00
2007	β	1.90	1.91
	s	0.14	0.15
	t	13.55	12.75
	p	0.00	0.00
2008	β	–1.82	–1.68
	s	0.18	0.19
	t	–10.05	–9.01
	p	0.00	0.00
2009	β	2.59	2.58
	s	0.18	0.19
	t	14.40	13.92
	p	0.00	0.00
2010	β	–0.31	–0.20
	s	0.13	0.14
	t	–2.37	–1.50
	p	0.02	0.13

		Without lagged gross alpha	With lagged gross alpha
2011	β	–0.54	–0.61
	s	0.15	0.16
	t	–3.64	–3.92
	p	0.00	0.00
2012	β	0.80	0.78
	s	0.11	0.12
	t	7.02	6.55
	p	0.00	0.00
2013	β	1.13	1.18
	s	0.13	0.13
	t	8.99	9.14
	p	0.00	0.00
2014	β	–0.60	–0.54
	s	0.12	0.13
	t	–4.78	–4.12
	p	0.00	0.00
Intercept	β	0.70	0.89
	s	0.15	0.16
	s	4.80	5.72
	p	0.00	0.00
N		22,716	19,341
R-Squared		7.1%	7.7%
Adj. R-Squared		7.0%	7.6%
RMSE		4.93	4.91

Variable key
β = coefficient
s = standard error
t = t-statistic
p = p-value

Notes: The intercept is not the average alpha in the sample; it reflects a base starting point for the model that a fund is in the large-cap blend category, that it is an index fund, and that it is observed in 2015. For reference, the gross alphas of three large S&P 500 Index funds were about 1% in 2015. Heteroskedasticity-robust standard errors are in parentheses.

Source: Vanguard calculations based on data from Morningstar.

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