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The Effect of Management Design on the Portfolio Concentration and Performance of Mutual Funds

Eitan Goldman, Zhenzhen Sun, and Xiyu (Thomas) Zhou

We show that the performance of actively managed equity mutual funds increases when portfolios are concentrated in the top one or two stocks within each industry sector. Funds managed by a single manager have much more concentrated portfolios, tend to perform better, and have higher expense ratios than funds managed by multiple managers. We observe that when a fund's management design is changed from single manager to multiple managers, the portfolio's within- and cross-sector concentration, performance, and expense ratios decrease.

The economic role of actively managed equity mutual funds is to delegate the stock selection decisions of individual investors to professional fund managers. The general belief is that these fund managers can generate abnormal returns relative to passive investment strategies. There is an ongoing debate among academics regarding whether actively managed funds outperform passive mutual funds or index funds. Many studies have found that active fund managers do not outperform the market—for example, Wermers (2000) showed that, on average, actively managed funds do not outperform the market after fees and expenses.

The finding that the average actively managed fund does not generate abnormal returns has led researchers to investigate what limits the ability of fund managers to generate performance. For example, Ackermann and Ravenscraft (1999) focused on regulatory restrictions faced by funds; Ellis (2014) argued that the lack of private information is a hindrance. A recent strand of research has examined fund or manager characteristics that affect mutual fund performance in order to identify which mutual funds perform better.[1]

Our study builds on the literature that has identified portfolio concentration as a key dimension that affects performance (e.g., Brands, Brown, and Gallagher 2005; Kacperczyk, Sialm, and Zheng 2005; Ivković, Sialm, and Weisbenner 2008; Cohen, Polk, and Silli 2010; Huij and Derwall 2011) and extends it in several directions. First, many of these studies measured the concentration of portfolios on the basis of concentration across industry sectors, but we found an additional, marginal impact on performance by within-sector concentration. This finding strengthens the conclusion that concentration has more to do with mutual fund ability than with picking up abnormal returns associated with industry momentum strategies, which also lead to industry-concentrated portfolios (see Wu 2015). Second and perhaps more important, we identified the organizational design behind the loss of abnormal returns associated with less concentrated portfolios. In particular, we found that mutual funds run by a *single manager* tend to have a much higher portfolio concentration, both across and within industries, than funds run by *multiple managers*. We further found that when funds' management designs are changed from single manager to multiple managers (or from multiple to single), portfolio concentration decreases (increases) and performance deteriorates (improves).

To construct measures of mutual fund portfolio concentration, we followed Kacperczyk et al. (2005), who first showed that mutual funds with portfolios concentrated in a few industry sectors tend to outperform. They argued that this cross-sector concentration is an indication of fund managers' self-assurance and ability. Similarly, we constructed an industry concentration index (ICI) on the basis of 10 industry sectors.[2] In addition, we developed a new within-sector concentration index (WCI) to capture the degree of mutual fund portfolio concentration within each of the 10 industry sectors. Our

Eitan Goldman is associate professor of finance at the Kelley School of Business, Indiana University, Bloomington. Zhenzhen Sun is assistant professor of finance at the School of Business, Siena College, Loudonville, New York. Xiyu (Thomas) Zhou is professor of finance at the School of Management, University of Alaska, Fairbanks.

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multivariate analysis under various model specifications demonstrates that both cross-sector and within-sector measures of portfolio concentration positively affect fund performance.

In measuring the organizational design and complexity of mutual funds, we faced the challenge that many characteristics of organizational design are not readily observable. Because of this data limitation, we focused on one specific area of organizational design: the number of managers running a fund. We partitioned our sample into single-manager and multiple-manager funds and compared their portfolios on the basis of WCI, (cross-sector) ICI, performance, and expense.

The idea that organizational design may affect fund performance is based on theoretical work on the potential limitations of managing multi-division firms, as modeled in Stein (2002). Applying these concepts to mutual funds, Baks (2003) found that over 50% of fund performance can be attributed to the mutual fund's firm rather than the fund's manager(s). Chen, Hong, Huang, and Kubik (2004) found that organizational diseconomies, as measured by fund size, erode mutual fund performance. Thus, both Baks (2003) and Chen et al. (2004) pointed to funds' organizational designs as major drivers of performance. Chen, Hong, Jiang, and Kubik (2013) looked into whether outsourced portfolios outperform and found that outsourcing erodes mutual fund performance because of diluted incentives.

In our study, we took a different approach by examining whether the design of the management structure—namely, single manager or multiple managers—affects the fund's investment concentration and thus performance. We found that funds run by a single manager tend to have a much higher WCI and ICI, significantly better performance, and a much higher expense ratio than funds run by multiple managers. Regressing a fund's performance on its WCI and ICI in a multivariate analysis, we found that both WCI and ICI retain a significant positive impact on fund performance. Moreover, we found that older funds and funds with longer-serving managers tend to perform worse.

As already mentioned, several previous studies are closely related to our study (e.g., Brands et al. 2005; Ivković et al. 2008; Cohen et al. 2010; Huij and Derwall 2011). Brands et al. (2005) defined portfolio concentration as the extent to which the portfolio deviates from the market portfolio (i.e., the Australian Stock Exchange S&P/ASX 300) and found a positive relationship between the performance of actively managed portfolios and portfolio concentration. Ivković et al. (2008) looked at individual investors' portfolio concentration and found that investors with focused portfolios are better informed than those with diversified portfolios. Cohen et al. (2010) showed that a fund manager's absolute best idea, as measured by the manager's preferred stock, systematically outperforms the portfolio that the manager runs. Finally, Huij and Derwall (2011) measured portfolio concentration as the extent to which the fund manager allocates funds across multiple investment strategies and multiple market segments. They found that mutual funds concentrating on investment styles, sectors, and countries tend to have larger tracking errors and to outperform the less concentrated mutual funds.

Our study differs from these studies in (1) our expanding the notion of portfolio concentration to include not only cross-sector concentration but also within-sector concentration and (2) our result that an important source of portfolio concentration is the fund's management design.

Data

We obtained our data from the CRSP Survivor-Bias-Free US Mutual Fund Database and the Thomson Financial CDA/Spectrum holdings database. The CRSP Mutual Fund Database provides information on fund returns, total net assets, investment objectives, expense ratios, turnover, and other fund characteristics for all US-based mutual funds. The Thomson Financial CDA/Spectrum database provides information (quarterly or semiannual) on the stock holdings of US mutual funds. As Daniel, Grinblatt, Titman, and Wermers (1997) argued, the Thomson Financial CDA/Spectrum database does not have a survivorship problem.

Following Wermers (2000), we merged the CRSP database with the CDA/Spectrum database. We first matched the funds in the two databases by fund name and ticker symbol, keeping only actively managed US domestic equity funds. We then combined the multiple share classes of each fund in the CRSP database into a single fund. We calculated the returns of a multi-class fund as the weighted average returns across share classes, using total net assets as the weight. We similarly calculated the fund expense ratios, turnover ratios, and other characteristics that we used in our analysis. To ensure robust statistical inferences, we excluded all funds with a total net asset value of less than $500,000 or with fewer than 10 assets. Finally, we dropped all funds with a history of less than 12 months because we needed a minimum of 12 months' history to calculate the funds' past annual performance. The final matched sample comprised 3,895 unique funds and 35,253 fund-years over 1990–2012.

Portfolio Concentration Indexes and Performance Measures

In this section, we discuss our within-sector and cross-sector concentration indexes as well as the performance measures we calculated using multi-factor alphas.

Within-Sector Concentration Index. To explore the relationship between mutual fund performance and within-sector portfolio concentration, we constructed two within-sector concentration indexes for each fund-year:

$$\text{AdjTop1} = \sum_{i=1}^{10} S^i \times \frac{W_i^1}{\omega_i^1} \quad (1)$$

$$\text{AdjTop2} = \sum_{i=1}^{10} S^i \times \frac{W_i^2}{\omega_i^2}, \quad (2)$$

where

S^i = the weight of the fund's portfolio in sector i (i is 1–10)

W_i^1 = the weight of the fund's holdings of the most heavily invested stock in sector i (calculated as the fund's holdings of the most heavily invested stock in sector i divided by the fund's total stock holdings in sector i)

W_i^2 = the weight of the fund's total holdings of the two most heavily invested stocks in sector i (calculated as the fund's holdings of the two most heavily invested stocks in sector i divided by the fund's total stock holdings in sector i)

ω_i^1 = the weight of the market capitalization of the company with the most heavily invested holdings in sector i (calculated as the market capitalization of the company with the most heavily invested holdings in sector i divided by the total market capitalization of all listed companies in sector i)

ω_i^2 = the weight of the total market capitalization of the two companies with the most heavily invested holdings in sector i (calculated as the market capitalization of the two companies with the most heavily invested holdings in sector i divided by the total market capitalization of all listed companies in sector i)[3]

AdjTop1 and AdjTop2 = the average of these multiples (i.e., $W_i^1/\omega_i^1, W_i^2/\omega_i^2$) weighted by a fund's portfolio weights $\left(S^i\right)$ in each of the 10 industry sectors

The variables AdjTop1 and AdjTop2 measure to what degree a fund, on average, concentrates its investments within each sector. For actively managed equity funds, the higher the variables, the more the fund's management concentrates its portfolio within a sector.

Note that the way we constructed the WCI means that it does not reflect the absolute degree of portfolio concentration within each sector. On the contrary, it takes into account the size of the top (selected) stocks. All else being equal, the smaller the size of a top stock, the lower the weight of the stock in its industry sector (ω in Equations 1 and 2) and the larger the WCI.

Kacperczyk–Sialm–Zheng Cross-Sector Industry Concentration Index. We also applied the industry concentration index as a control variable. Kacperczyk, Sialm, and Zheng (2005) found a positive relationship between fund performance and the fund portfolio's cross-sector ICI. We followed their study in constructing the ICI:

$$\text{ICI}_t = \sum_{i=1}^{10} \left(W_{i,t} - \omega_{i,t}\right)^2. \quad (3)$$

A fund's ICI in year t is the sum of the square of the differences between the weights of each of the 10 industry sectors in a fund's portfolio ($W_{i,t}$) and the weights of the industry sectors of the total stock market ($\omega_{i,t}$). This index measures the degree to which a mutual fund's portfolio differs from the market portfolio at the industry sector level. If the weights of a fund's investments in all the industries are the same as those of the market portfolio, the index is equal to zero.

Although the ICI reveals the fund manager's preference in industry sectors, it says little about the fund manager's stock picking. But the WCI shows the strength of the manager's preference for the top one or two stocks within each sector. The two indexes complement each other in depicting how concentrated a fund portfolio is.

Performance Measures with Multi-Factor Alphas. To measure the average monthly abnormal performance of mutual funds, we calculated multi-factor alphas for each fund-year. For each fund i in year t, we applied two alternative specifications, the Fama–French three-factor model (see Fama and French 1993) and the Carhart four-factor model[4] (see Carhart 1997):

$$R_{i,t} - R_{ft} = \alpha_{i,t} + \beta_1 \text{RMRF}_t + \beta_2 \text{SMB}_t + \beta_3 \text{HML}_t + \varepsilon_{i,t} \quad (4)$$

$$R_{i,t} - R_{ft} = \alpha_{i,t} + \beta_1 \text{RMRF}_t + \beta_2 \text{SMB}_t + \beta_3 \text{HML}_t + \beta_4 \text{UMD}_t + \varepsilon_{i,t}, \quad (5)$$

where

$R_{i,t} - R_{ft}$ = the return on fund i in month t in excess of the monthly T-bill rate

$RMRF_t$ = the value-weighted return on the market minus the monthly T-bill rate in month t

SMB_t = the small-minus-big portfolio

HML_t = the high-minus-low portfolio

UMD_t = the momentum portfolio[5]

We used the annualized three-factor alpha (Alpha3) and the four-factor alpha (Alpha4) in our analysis.

Summary Statistics

Table 1 reports summary statistics of our mutual fund sample over 1990–2012. The mutual funds in our sample show wide variation in their characteristics. The minimum value of AdjTop1 (AdjTop2) is 1.60 (1.57), whereas the maximum is more than 4,850 (3,160). The 25th percentile of AdjTop1 (AdjTop2) is 12.85 (9.64), whereas the 75th percentile is 209.13 (150.45). The two means are 268.90 and 186.00, respectively. The minimum value of the ICI is virtually zero, which means that the weights of all sectors of that fund's portfolio mimic those of the market portfolio. The 25th and 75th percentile values are 0.65% and 3.31%, respectively. The maximum is 62.07%. As for the number of stocks held in the fund's portfolio (HoldNo), our sample includes mutual funds that hold as few as 11 assets up to those that hold as many as 3,025 assets, with an average number of 144. The turnover ratio is between 0.22% and 2,068%. The average value is 78.59%. The average annual expense ratio is 1.24%. TNA (total net assets) ranges from $820,000 to over $61.5 billion. The average TNA is $854 million. The average age of a fund is 11 years, and the average tenure of a fund manager is 6 years. The annual three-factor (four-factor) alpha is, on average, –1.25% (–1.30%). These two net performance measures are consistent with earlier studies.

Table 2 reports the correlations between these portfolio characteristics. As expected, the correlation between AdjTop1 and AdjTop2 is very high at 87%. Interestingly, the correlation between the ICI and the two within-sector concentration indexes are also positive at 23% and 18%, respectively. AdjTop1, AdjTop2, and the ICI all have positive correlations with an expense ratio of 24%, 23%, and 21%, respectively. Both AdjTop1 and AdjTop2 have a negative correlation with HoldNo of –11%. TNA has a negative correlation of –9%, –8%, and –6% with AdjTop1, AdjTop2, and the ICI, respectively.

Empirical Results

In this section, we present the results of both our univariate analysis and our multivariate analysis of the WCI. We also examine why some funds have higher portfolio concentration than others and describe our robustness test.

Univariate Analysis. To study the relationship between fund performance and the WCI, we sorted funds into 10 groups on the basis of the WCI and calculated the multi-factor fund performance (Alpha3 and Alpha4) for each group. We then computed the means of Alpha3 and Alpha4 across years within each of the 10 groups. The results are presented in **Table 3**. Overall, we see an almost monotonic relationship between a fund's alphas

Table 1. Summary Statistics, 1990–2012

Variable	*N*	Min.	P25	Mean	Median	Std. Dev.	P75	Max.
AdjTop1	35,253	1.60	12.85	268.90	49.37	674.13	209.13	4,850.51
AdjTop2	35,253	1.57	9.64	186.00	33.03	448.78	150.45	3,160.34
ICI (%)	35,220	0.00	0.65	2.88	1.48	4.50	3.31	62.07
HoldNo	35,253	11	48	144	74	271	122	3,025
Turnover (%)	35,220	0.22	26.13	78.59	54.37	112.98	98.37	2,067.95
Expense (%)	35,128	0.03	0.93	1.24	1.18	0.61	1.50	10.57
TNA ($ millions)	35,253	0.82	22.48	854.39	122.44	3,315.21	464.86	61,480.44
Age (years)	35,195	1	3	11	7	13	14	78
Tenure (years)	35,103	1	3	6	5	5	8	17
Alpha3 (%)	35,253	–8.91	–5.03	–1.25	–1.18	5.26	1.88	10.01
Alpha4 (%)	35,253	–8.84	–5.01	–1.30	–1.20	5.17	1.80	9.75

Notes: The summary statistics of the major fund characteristics used in our analysis include the number of fund-year combinations, minimum, 25th percentile (P25), mean, median, standard deviation, 75th percentile (P75), and maximum. The fund characteristics include the portfolio's within-sector concentration index AdjTop1 and AdjTop2, the cross-sector industry concentration index (ICI), HoldNo, turnover ratio, expense ratio, total net assets (TNA), and the annualized Fama–French three-factor alpha (Alpha3) and Carhart four-factor alpha (Alpha4). Age is the number of years since the fund began. Tenure is the number of years that the incumbent managers have managed the fund.

Table 2. Correlations, 1990–2012

	AdjTop1	AdjTop2	ICI	HoldNo	Turnover	Expense	TNA	Age	Tenure
AdjTop1	1.00	—	—	—	—	—	—	—	—
AdjTop2	0.87	1.00	—	—	—	—	—	—	—
ICI	0.23	0.18	1.00	—	—	—	—	—	—
HoldNo	–0.11	–0.11	–0.16	1.00	—	—	—	—	—
Turnover	0.08	0.07	0.07	–0.08	1.00	—	—	—	—
Expense	0.24	0.23	0.21	–0.27	0.21	1.00	—	—	—
TNA	–0.09	–0.08	–0.06	0.11	–0.07	–0.18	1.00	—	—
Age	–0.09	–0.09	–0.03	–0.05	–0.05	–0.09	0.32	1.00	—
Tenure	0.10	0.09	0.11	–0.08	–0.12	–0.03	0.22	0.29	1.00

Notes: This table shows the correlations between the major fund characteristics used in our analysis. See also notes to Table 1.

and its WCI, because the Spearman rank correlations are at least 78%.

Multivariate Analysis of the WCI. Even though the univariate analysis shows that funds with a higher WCI tend to outperform, that performance could be driven by a fund's other characteristics, such as the ICI, which is positively correlated with the WCI. To control other potential factors, we applied the following fixed-effect regression model to estimate the relationship between a fund's multifactor abnormal return and its WCI and other fund characteristics:

$$\begin{aligned}\alpha_{i,t}^{Model} &= \mathrm{INT} + \beta_1 \lg \mathrm{WCI}_{i,t-1} + \beta_2 \mathrm{ICI}_{i,t-1} \\ &+ \beta_3 \lg \mathrm{HoldNo}_{i,t-1} + \beta_4 SQ \lg \mathrm{HoldNo}_{i,t-1} \\ &+ \beta_5 \lg \mathrm{TNA}_{i,t-1} + \beta_6 \mathrm{SQ} \lg \mathrm{TNA}_{i,t-1} \\ &+ \beta_7 \mathrm{Turnover}_{i,t-1} \\ &+ \beta_8 \mathrm{Expense}_{i,t-1} + \mu_i + \eta_{t-1} + \varepsilon_{i,t-1},\end{aligned} \tag{6}$$

where $\alpha_{i,t}^{Model}$ is the annualized alpha of fund i in year t for either the Fama–French three-factor model or the Carhart four-factor model. The main independent variables are the (natural) logarithm of the WCI[6] (either AdjTop1 or AdjTop2) and the

Table 3. Decile Portfolios: Multi-Factor Performance Measures

	Sorted by AdjTop1		Sorted by AdjTop2	
Decile	Alpha3 (%)	Alpha4 (%)	Alpha3 (%)	Alpha4 (%)
D1	–2.58	–2.76	–2.59	–2.84
D2	–2.33	–2.29	–2.37	–2.46
D3	–1.68	–1.72	–1.64	–1.68
D4	–1.67	–1.56	–1.58	–1.52
D5	–1.45	–1.44	–1.37	–1.46
D6	–1.32	–1.37	–1.29	–1.34
D7	–1.19	–1.21	–1.18	–1.32
D8	–1.18	–1.19	–1.17	–1.16
D9	0.37	0.22	0.21	0.25
D10	0.55	0.37	0.49	0.57
2nd half – 1st half (%)	1.39***	1.32***	1.32***	1.39***
	(2.91)	(2.74)	(2.84)	(2.92)
8th decile – 3rd decile (%)	0.50***	0.53***	0.47**	0.52***
	(2.58)	(2.69)	(2.16)	(2.63)
Spearman rank correlation	0.84***	0.83***	0.79***	0.78***
	(0.00)	(0.00)	(0.00)	(0.00)

Notes: This table shows the annualized Fama–French three-factor alpha (Alpha3) and the Carhart four-factor alpha (Alpha4) for portfolios sorted by AdjTop1 and AdjTop2. For each year, we sorted funds into deciles on the basis of AdjTop1 and AdjTop2 and then calculated the means of Alpha3 and Alpha4 within each group. We also estimated the difference between the second half of the sample and the first half and the difference between the eighth decile and the third decile; *t*-statistics (in parentheses) are reported for the differences. The Spearman rank correlations are also reported, together with their *p*-values (in parentheses).

**Significant at the 5% level.
***Significant at the 1% level.

(cross-sector) ICI. We also included several control variables suggested by previous researchers. Shawky and Smith (2005) found a curvilinear relationship between fund performance and the number of assets held in the fund's portfolio. So, we included both lgHoldNo (the logarithm of the number of securities held) and its square term (SQlgHoldNo). Chen et al. (2004) found that actively managed mutual fund performance deteriorates with an increase in fund size. Perold and Salomon (1991) suggested that performance first increases then decreases with an increase in fund size. Thus, we added lgTNA (the logarithm of the fund's net assets) and its square (SQlgTNA) as regressors. Grinblatt and Titman (1994) found the turnover ratio to be positively related to performance because hard-working managers turn over their portfolios more often. We included expense because our return data were reported on an after-expense basis. Finally, we included a fixed-fund effect (μ_i) and a fixed-year effect (η_{t-1}), following Greene (1997) and Chevalier and Ellison (1999). To reduce the possible impact of endogeneity, we made all the independent variables one year lagged compared with the dependent variables. The results are presented in **Table 4**.

In the first three columns, the Fama–French three-factor alpha is the dependent variable. The coefficients of the WCI (lgAdjTop1 in column 1 and lgAdjTop2 in column 2) are significantly positive. As a diversified equity fund increasingly focuses on the top one or two assets within each industry sector, its performance improves. The 25th and 75th percentiles of the AdjTop1 are 12.85 and 209.1, respectively, and the natural logarithms of these two values are 2.55 and 5.34. All else being equal, a fund that ranks 75th in AdjTop1 will outperform its 25th percentile counterparts by 0.50% a year.[7] So, this result is economically significant. Consistent with Kacperczyk et al. (2005), we found a significantly positive relationship between the (cross-sector) ICI and fund performance, which suggests that as a fund's portfolio becomes more concentrated in a few industry sectors, its performance improves. All else being equal, when a fund's ICI moves from 0.65% (25th percentile) to 3.31% (75th percentile), its annual performance improves by more than 3%. Clearly, the differences between a mutual fund portfolio's within- and cross-sector concentration indexes contribute significantly to fund performance.

The coefficients of the control variables are largely consistent with findings in previous studies. The coefficient of lgHoldNo is positive and that of SQlgHoldNo is negative, suggesting a curvilinear relationship between the number of assets and performance.[8] This finding is consistent with Shawky and Smith (2005). The coefficient of lgTNA is positive and that of SQlgTNA is negative. Thus, the results show that performance initially increases with the size of the portfolio and then starts to decrease beyond an interior maximum. The coefficient of turnover is negative but not statistically significant, which is inconsistent with Grinblatt and Titman (1994). A possible explanation for this inconsistency is that the fund managers traded excessively to give the illusion of working hard after they read the study. Expense ratio has a negative impact on performance (which is intuitive). The results also show that older funds and funds with longer-serving managers tend to perform worse, suggesting perhaps that both the fund's firm and the fund's management work less hard over time because of the entrenchment effect.

To control for various investment objectives, we included four dummy variables (aggressive growth, equity income, growth, and small company) that are equal to 1 when a fund's investment objective is one of these four variables and 0 otherwise; the results are reported in column 3.[9] The coefficient of lgAdjTop1 is 0.14 (significant at the 1% level). The results for the other variables are similar to those in the first two columns. We then re-ran these regressions using the Carhart four-factor alpha as the dependent variable. To save space, we report the results of only one regression in column 4.[10] Finally, to explore the impact of the WCI on the overall wealth effect, we used gross abnormal return (calculated as annualized alpha plus yearly expense ratio) as the dependent variable and repeated the regressions in columns 1 and 3. The results are qualitatively similar across the board.[11] The coefficients of the WCI in the last two columns are similar to their counterparts in columns 1 and 3, whereas the coefficients of the ICI are roughly 40% bigger and are statistically significant at the 1% level. The results for the control variables are largely similar.

Overall, as shown in Table 4, we found that when a mutual fund's portfolio is concentrated in one or two stocks within each of the 10 industry sectors, its performance improves—after controlling for the impact of the portfolio's ICI, its size, the fund's investment objectives, and a litany of other control variables. Also, older funds and longer-serving managers tend to perform worse.

Why Do Some Funds Have Higher Portfolio Concentration Than Others? Because of the apparent importance to a fund's performance of its WCI and ICI, we wanted to learn why some funds have higher portfolio concentration than others. Baks (2003) concluded that the organizational design of a mutual fund has an extremely important impact on fund performance. Chen et al. (2004) tested some empirical implications set forth by Stein (2002) and found that organizational diseconomies do erode mutual fund performance.

Table 4. Multivariate Analysis

	Alpha3 (%)	Alpha3 (%)	Alpha3 (%)	Alpha4 (%)	Gross Return (%)	
Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	–0.71	–0.59	0.44	–0.70	0.56	1.72
	(–0.66)	(–0.55)	(0.38)	(–0.66)	(0.71)	(1.69)
lgAdjTop1	0.18***		0.14***	0.19***	0.21***	0.17***
	(6.11)		(3.67)	(6.60)	(7.27)	(4.47)
lgAdjTop2		0.17***				
		(5.64)				
ICI	1.15***	1.25***	1.54***	1.26***	1.64***	2.05***
	(2.95)	(3.10)	(3.21)	(3.08)	(3.30)	(3.60)
lgHoldNo	0.08	0.11	0.21	0.07	0.19	0.31
	(0.21)	(0.26)	(0.51)	(0.19)	(0.72)	(0.77)
SQlgHoldNo (%)	–2.45**	–2.36**	–1.82**	–2.32**	–2.27**	–1.65**
	(–2.26)	(–2.33)	(–2.09)	(–2.43)	(–2.30)	(–2.21)
lgTNA	0.36***	0.36***	0.36***	0.32***	0.29***	0.29***
	(4.75)	(4.74)	(4.77)	(4.30)	(3.81)	(3.85)
SQlgTNA (%)	–1.01**	–1.00**	–0.99**	–0.95**	–1.14**	–1.12**
	(–2.24)	(–2.23)	(–2.22)	(–2.20)	(–2.40)	(–2.37)
Turnover (%)	–0.03	–0.03	–0.02	–0.01	–0.06	–0.05
	(–0.72)	(–0.74)	(–0.55)	(–0.20)	(–1.42)	(–1.23)
Expense (%)	–0.25**	–0.24**	–0.25***	–0.25**		
	(–2.50)	(–2.44)	(–2.60)	(–2.46)		
Age (years)	–0.06***	–0.06***	–0.06***	–0.06***	–0.06***	–0.06***
	(–12.78)	(–12.72)	(–12.47)	(–12.86)	(–11.44)	(–11.11)
Tenure (years)	–0.05***	–0.05***	–0.05***	–0.06***	–0.05***	–0.05***
	(–5.99)	(–6.01)	(–6.00)	(–6.95)	(–6.05)	(–6.07)
Aggressive growth			–0.66***			–0.65***
			(–3.82)			(–3.73)
Equity income			–0.96***			–0.96***
			(–3.77)			(–3.79)
Growth			–0.84***			–0.50***
			(–4.63)			(–4.87)
Small company			–0.52***			–0.50***
			(–2.65)			(–2.54)
Fixed-fund effect	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-year effect	Yes	Yes	Yes	Yes	Yes	Yes
N	34,176	34,176	34,176	34,176	34,176	34,176
Adjusted R^2	0.35	0.37	0.40	0.37	0.39	0.42

Notes: This table shows the results for the cross-sectional time-series pooled regressions of fund performance on fund characteristics. The dependent variables in year *t* are the annualized Fama–French three-factor alpha (Alpha3) in columns 1–3, the Carhart four-factor alpha (Alpha4) in column 4, and the gross return (Alpha3 + expense) in columns 5 and 6. The main independent variables in year *t* – 1 include the logarithm of AdjTop1 (lgAdjTop1), the logarithm of AdjTop2 (lgAdjTop2), the cross-sector industry concentration index using 10 broadly defined industry classifications (ICI), the logarithm of HoldNo and its squared value, the logarithm of total net assets and its squared value, turnover ratio, expense ratio, fund age, and manager tenure. We also considered four dummy variables (aggressive growth, equity income, growth, and small company) to control for the fund's investment objective. The four dummy variables are equal to 1 when a fund's investment objective is one of the four dummy variables and 0 otherwise. The regressions include the fixed-fund effect and the fixed-year effect. The *t*-statistics (in parentheses) are based on standard errors that are clustered in two ways (by time and fund).

**Significant at the 5% level.
***Significant at the 1% level.

The organizational design of a mutual fund is virtually unobservable, making it very difficult to test empirically. One of the few exceptions is in variations in the number of managers running a fund. A fund's prospectus usually has six categories concerning "number of managers": one, two, three, four, management team, and multiple managers.[12] We separated our data into these six categories. Panel A of **Table 5** reports our calculations of the means/variances of the portfolio concentration indexes and fund performance measures for each group—namely, the within-sector concentration indexes (both AdjTop1 and AdjTop2), the (cross-sector) industry concentration index (ICI), and the multi-factor risk-adjusted performance measures (the annualized Alpha3 and Alpha4). We also included fund size (TNA) and expense ratio (expense). Panel B compares the means of these variables regarding the funds run by a single manager and regarding those run by various categories of multiple managers. We found that as the number goes from one manager to two managers, three managers, four managers, management team, and multiple managers, the within- and cross-sector concentration indexes (AdjTop1, AdjTop2, and the ICI), the expense ratio, and two performance measures all largely decrease monotonically (the differences between alphas range from 31 bps to 130 bps a year). This finding is consistent with Chen et al. (2004), who found that funds managed by a single manager perform better than funds run by multiple managers—by almost 0.50% a year. On average, funds managed by multiple managers are much larger, followed by those managed by four managers. As Table 5 shows, we found that, on average, funds run by a single manager have more-concentrated portfolios and achieve better performance; their expense ratios also tend to be much higher.

On the basis of the numbers in Table 5, we should not conclude only that single manager is a better management design for pursuing better performance because those funds tend to have higher within- and cross-sector portfolio concentration. Better performance may be due to some other driving force. For example, funds with four managers and multiple managers tend to be larger, and according to Chen et al. (2004), larger fund size leads to worse performance, all else being equal. Moreover, the results in Table 5 are based on static observations. We wanted to study the relationship between management design, portfolio concentration, and fund performance in a dynamic setting. To do so, we chose those funds that had changed their management design during our sample period and compared the degrees of portfolio concentration, performance, and expense before and after the change.

Table 6 reports our results. First, note that without exception, when the management design is changed from single manager to multiple managers, the

Table 5. Summary Statistics across Funds Based on Number of Managers
(*p*-values in parentheses)

No. of Managers	*N*	AdjTop1	AdjTop2	ICI (%)	Alpha3 (%)	Alpha4 (%)	TNA ($ millions)	Expense Ratio
A. Means/standard deviations of variables								
1	768	316.23/784.24	224.51/526.01	3.25/5.12	–0.47/3.88	–0.51/4.24	1,160.47/4,083	1.35/0.67
2	500	255.12/605.75	182.88/413.65	2.90/4.24	–0.78/4.32	–0.92/5.25	577.94/1,441	1.28/0.47
3	217	207.37/460.01	151.39/316.44	2.36/3.58	–1.22/4.69	–1.33/5.46	799.64/1,498	1.23/0.46
4	111	179.40/368.89	128.56/241.34	2.21/1.93	–1.58/4.86	–1.52/4.57	2,877.59/5,210	1.12/0.52
Team	548	186.56/475.08	137.41/339.86	1.95/3.39	–1.69/5.12	–1.69/4.82	1,013.17/3,536	1.10/0.47
Multiple	115	114.68/235.10	62.64/130.92	1.84/2.05	–1.76/5.01	–1.81/4.73	6,284.15/8,930	0.81/0.31
B. Differences between means across funds managed by different numbers of managers								
1 vs. 2		37.20 (0.004)	13.08 (0.124)	0.68 (0.003)	0.31 (0.000)	0.41 (0.000)	581.25 (0.000)	0.07 (0.012)
1 vs. 3		87.80 (0.000)	51.02 (0.010)	0.83 (0.001)	0.75 (0.001)	0.82 (0.001)	440.54 (0.000)	0.10 (0.004)
1 vs. 4		98.89 (0.000)	64.67 (0.002)	1.03 (0.000)	1.11 (0.002)	1.01 (0.003)	–1,761.20 (0.000)	0.18 (0.001)
1 vs. Team		131.33 (0.000)	78.83 (0.000)	1.21 (0.000)	1.22 (0.000)	1.18 (0.000)	141.36 (0.003)	0.21 (0.000)
1 vs. Multiple		186.23 (0.000)	154.42 (0.000)	1.15 (0.000)	1.29 (0.000)	1.30 (0.000)	–5,021.50 (0.000)	0.47 (0.000)

Notes: This table reports the means/standard deviations of the main variables used in our analysis across groups based on the number of managers as well as the differences between means across funds managed by different numbers of managers. For each year, we counted the number of managers and sorted them into six groups. The groups Team and Multiple indicate that the funds are managed by a management team or by multiple managers. The main variables include the number of observations (*N*), AdjTop1, AdjTop2, the ICI, the annualized Fama–French three-factor alpha (Alpha3), the Carhart four-factor alpha (Alpha4), total net assets, and the expense ratio. Panel A reports the means and standard deviations of these variables in each group. We calculated the means and standard deviations of the variables for each year and then averaged them over time. Panel B shows the differences in the variables between funds managed by a single manager and funds managed by more than one manager.

Table 6. Summary Statistics for Changes in Number of Managers
(*p*-values in parentheses)

No. of Managers	*N*	AdjTop1	AdjTop2	ICI (%)	Alpha3 (%)	Alpha4 (%)	TNA ($ millions)	Expense Ratio
1 to 2	785	–61.15	–37.25	–0.38	–0.26	–0.18	–35.83	–0.04
		(0.012)	(0.016)	(0.008)	(0.004)	(0.006)	(0.148)	(0.255)
1 to 3	253	–75.26	–39.77	–0.45	–0.47	–0.46	–81.25	–0.06
		(0.009)	(0.024)	(0.005)	(0.005)	(0.005)	(0.195)	(0.158)
1 to 4	114	–84.10	–72.52	–0.69	–0.63	–0.60	345.17	–0.16
		(0.127)	(0.267)	(0.101)	(0.019)	(0.016)	(0.028)	(0.099)
1 to Team	539	–98.96	–67.01	–0.78	–0.80	–0.79	–109.52	–0.18
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.002)
1 to Multiple	107	–89.27	–68.31	–0.79	–1.28	–1.25	445.33	–0.47
		(0.063)	(0.102)	(0.014)	(0.001)	(0.002)	(0.001)	(0.000)
2 to 1	525	12.55	14.31	0.18	0.41	0.38	49.54	0.08
		(0.002)	(0.199)	(0.014)	(0.000)	(0.000)	(0.161)	(0.107)
3 to 1	129	16.18	14.79	0.31	0.63	0.64	21.68	0.14
		(0.017)	(0.257)	(0.002)	(0.003)	(0.001)	(0.087)	(0.063)
4 to 1	370	40.61	59.50	0.58	0.82	0.85	–12.75	0.37
		(0.040)	(0.000)	(0.004)	(0.002)	(0.001)	(0.048)	(0.086)
Team to 1	328	32.36	40.23	0.54	1.13	0.97	54.95	0.47
		(0.058)	(0.044)	(0.013)	(0.000)	(0.000)	(0.032)	(0.102)
Multiple to 1	112	89.42	75.21	0.98	1.24	1.16	–121.33	0.56
		(0.317)	(0.139)	(0.163)	(0.002)	(0.003)	(0.329)	(0.443)

Notes: This table shows the differences in the main variables used in our analysis arising from changes in the number of managers. The main changes in the number of managers are from one manager to two managers, three managers, four managers, team management, and multiple managers, and vice versa. The main variables include the number of observations (*N*), AdjTop1, AdjTop2, the ICI, the annualized Fama–French three-factor alpha (Alpha3), the Carhart four-factor alpha (Alpha4), total net assets, and the expense ratio. The differences in the variables are calculated as the variable in year $t + 1$ minus the variable in year $t - 1$ when the changes occur in year t.

portfolio concentration indexes all decrease, performance deteriorates, and the expense ratio decreases. The reverse is also true. These changes are consistent whenever the average fund size increases or decreases in the same period. When the management design is changed from single manager to two managers, in two years, those funds' average AdjTop1 (AdjTop2) decreases by more than 61 (37) and their ICI goes down by 0.38%. Overall, the funds' annual three-factor (four-factor) alpha goes down by 26 (18) bps. An increase in the number of managers (the other categories) leads to even worse performance. For example, when the management design is changed from single manager to multiple managers, AdjTop1 (AdjTop2) decreases by more than 89 (68) and the ICI decreases by 0.79%. Because the mean of AdjTop1 (AdjTop2) is 269 (186) and the AdjTop1 and AdjTop2 of an index fund are 1, approximately one-third of our measurement of the within-sector concentration disappears. For the same reason, because the mean of the ICI in our sample is 2.88%, more than a quarter of the measurement of the cross-sector concentration is lost. The funds' overall risk-adjusted performance, Alpha3 (Alpha4), deteriorates by 1.28% (1.25%). But not all the changes are bad when funds move from single manager to multiple managers. We found that the expense ratio is lowered by 4 bps to 47 bps when the management design is changed from single manager to multiple managers and other designs.

Overall, these findings show that when funds move from single manager to multiple managers, the degree of portfolio concentration (both within and cross sector) declines. Fund performance deteriorates, and the funds' annual expense ratios also decrease.

Robustness Test. After finding that management design has such a huge impact on funds' portfolio concentration and performance, we wanted to re-run the multivariate analysis of fund performance and portfolio concentration indexes and other control variables, with different management designs added as dummy variables. We used "single manager" as the base category and added five dummy variables (D2, D3, D4, D-Team, and D-Multiple) that are equal to 1 when the management design is two managers, three managers, four managers, management team, or multiple managers and 0 otherwise. **Table 7** reports the model specifications, similar to those shown in Table 4.

Table 7. Multivariate Analysis with Dummy Variables

	Alpha3 (%)	Alpha3 (%)	Alpha3 (%)	Alpha4 (%)	Gross Return (%)	
Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	–0.80	–0.68	0.45	–0.80	0.47	1.74
	(–0.75)	(–0.64)	(0.40)	(–0.76)	(0.63)	(1.70)
lgAdjTop1	0.17***		0.13***	0.18***	0.21***	0.16***
	(5.96)		(3.42)	(6.45)	(7.12)	(4.23)
lgAdjTop2		0.17***				
		(5.52)				
ICI	0.95***	1.05***	1.38***	1.05***	1.46***	1.90***
	(2.78)	(2.86)	(3.11)	(2.87)	(3.16)	(3.49)
lgHoldNo	0.01	0.01	0.13	0.03	0.10	0.23
	(0.03)	(0.02)	(0.31)	(0.07)	(0.24)	(0.57)
SQlgHoldNo (%)	–3.32**	–3.24**	–2.60**	–3.26**	–3.14**	–2.44**
	(–2.29)	(–2.31)	(–2.04)	(–2.28)	(–2.13)	(–2.04)
lgTNA	0.36***	0.36***	0.36***	0.32***	0.29***	0.29***
	(4.73)	(4.72)	(4.76)	(4.29)	(3.79)	(3.83)
SQlgTNA (%)	–1.05	–1.04	–1.02	–0.99	–1.18	–1.15
	(–1.28)	(–1.28)	(–1.26)	(–1.26)	(–1.45)	(–1.42)
Turnover (%)	–0.03	–0.03	–0.02	–0.01	–0.01	–0.01
	(–0.68)	(–0.70)	(–0.51)	(–0.16)	(–1.39)	(–1.19)
Expense (%)	–0.24**	–0.23**	–0.25***	–0.24**		
	(–2.47)	(–2.41)	(–2.57)	(–2.40)		
Age (years)	–0.06***	–0.06***	–0.06***	–0.06***	–0.06***	–0.06***
	(–12.80)	(–12.74)	(–12.47)	(–12.89)	(–11.44)	(–11.09)
Tenure (years)	–0.05***	–0.05***	–0.05***	–0.06***	–0.05***	–0.05***
	(–5.76)	(–5.77)	(–5.79)	(–6.77)	(–5.81)	(–5.85)
Aggressive growth			–0.71***			–0.69***
			(–4.07)			(–3.98)
Equity income			–0.98***			–1.00***
			(–3.87)			(–3.88)
Growth			–0.89***			–0.94***
			(–4.88)			(–5.12)
Small company			–0.52***			–0.65**
			(–2.65)			(–2.54)
D2	–0.25***	–0.25***	–0.26***	–0.25***	–0.25***	–0.26***
	(–3.26)	(–3.29)	(–3.36)	(–3.30)	(–3.26)	(–3.36)
D3	–0.37**	–0.37**	–0.39***	–0.49***	–0.35**	–0.37**
	(–2.43)	(–2.46)	(–2.57)	(–3.32)	(–2.30)	(–2.44)
D4	–0.64**	–0.65**	–0.65**	–0.44***	–0.57**	–0.58**
	(–2.34)	(–2.36)	(–2.39)	(–3.70)	(–2.26)	(–2.30)
D-Team	–0.64***	–0.65***	–0.66***	–0.64***	–0.65***	–0.66***
	(–4.59)	(–4.61)	(–4.70)	(–4.79)	(–4.62)	(–4.73)
D-Multiple	–0.78	–0.79	–0.89	–0.86	–0.88	–0.89
	(–1.83)	(–1.82)	(–1.90)	(–1.84)	(–1.89)	(–1.92)
Fixed-fund effect	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-year effect	Yes	Yes	Yes	Yes	Yes	Yes
N	34,176	34,176	34,176	34,176	34,176	34,176
Adjusted R^2	0.38	0.39	0.41	0.39	0.41	0.44

Notes: This table reports the results for the cross-sectional regressions of fund performance on fund characteristics. The dependent variables in year *t* are the annualized Fama–French three-factor alpha (Alpha3) in columns 1–3, the Carhart four-factor alpha (Alpha4) in column 4, and the gross return (Alpha3 + expense) in columns 5 and 6. The main independent variables in year *t* – 1 include the logarithm of AdjTop1 (lgAdjTop1), the logarithm of AdjTop2 (lgAdjTop2), the industry concentration index measure using 10 broadly defined industry classifications (ICI), the logarithm of HoldNo and its squared value, the logarithm of total net assets and its squared value, turnover ratio, expense ratio, fund age, and manager tenure. We also considered four dummy variables (aggressive growth, equity income, growth, and small company) to control for a fund's investment objective, with the four dummy variables equal to 1 when a fund's investment objective is one of the four variables and 0 otherwise. We also added five dummy variables (D2, D3, D4, D-Team, and D-Multiple) for the number of managers, with the five dummy variables equal to 1 when a fund is run by two managers, three managers, four managers, a management team, or multiple managers and 0 otherwise. The regressions include the fixed-fund effect and the fixed-year effect. The *t*-statistics (in parentheses) are based on standard errors that are clustered in two ways (by time and fund).

**Significant at the 5% level.

***Significant at the 1% level.

Looking first at the results in columns 1–4, where the dependent variables are post-expense abnormal returns, we see that all the coefficients of the WCI remain positive and statistically significant; they are about as large as their counterparts in Table 4. The loadings of the ICI are positive and statistically significant and are about 85% as large as those in Table 4. The coefficients of the dummy variables are all negative and statistically significant, at least at the 10% level. The loadings of the D2, D3, D4, D-Team, and D-Multiple largely decrease monotonically, which is consistent with the results of the univariate analysis in Table 5. When gross abnormal returns are used in columns 5 and 6, the coefficients of the WCI become about 20% larger than those in columns 1 and 3. The coefficients of the dummy variables, representing different categories of managers, are similar to their counterparts in columns 1 and 3. We believe that these negative values for the dummy variables indicate organizational diseconomies not captured by the loss of portfolio concentration and other control variables in the estimation model.

Conclusion

In this article, we demonstrated empirically that mutual funds with a higher within-sector portfolio concentration exhibit a better abnormal performance. We showed that portfolios of funds managed by a single manager tend to have a higher degree of both within- and cross-sector concentration. A single-manager management design, on average, achieves a better net performance and has a higher expense ratio. When funds change their management design from single manager to multiple managers, the degree of both within- and cross-sector portfolio concentration is reduced and the post-expense abnormal performance of the funds deteriorates, although the average expense ratio is also lowered. The reverse occurs when funds move from multiple managers to single manager. The relationship between performance and degree of both within- and cross-sector portfolio concentration is significant after controlling for size and other characteristics, such as number of assets chosen, turnover, expense, and investment style. This result is robust to dummy variables representing different management designs. Our study extends the research of Kacperczyk et al. (2005) by including the within-sector concentration index in explaining fund performance. It also extends the research of Chen et al. (2004) by examining the implications of different management designs for funds' portfolio concentration, performance, and expense ratio.

Our study has several potential implications for mutual fund investors. First, all else being equal, equity mutual fund investors may be better off selecting funds with portfolios concentrated in the top one or two stocks (relative to the stocks' own size) within each sector. Investors could also benefit from selecting funds that are concentrated in a few industry sectors relative to the market portfolio. Second, investors may contemplate divesting from funds that switch from using a single manager to using multiple managers because of the potential deterioration in fund performance. In contrast, a fund's switch from using multiple managers to using a single manager may represent an investment opportunity. Investors should also be aware of older funds run by long-serving managers. Our study shows that such funds and/or managers tend to underperform. Additional empirical analyses that consider the persistence of fund performance should be conducted to verify these conjectures.

From the perspective of a mutual fund sponsor, our study raises several questions that largely center on management design. What are the main trade-offs between running a mutual fund with a single manager and running a fund with multiple managers? If more than one manager is responsible, should the managers manage as a team or independently? More specifically, why do funds run by multiple managers tend to have portfolios with a lower degree of within- and cross-sector concentration that perform worse? Is it because of "moral hazard in teams" (Holmstrom 1982)? If each manager (or subadvisory company) is responsible for investing a fixed percentage of the portfolio in a few industry sectors, how can the fund execute a sector rotation strategy—that is, move capital from a manager's control into the hands of another manager to invest in sectors that are likely to outperform? Our study also raises concerns about how to sustain a fund's performance as it ages and as the fund's managers remain at the same job year after year. We hope that future studies will address these issues.

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Notes

1. Focusing on manager characteristics, Chevalier and Ellison (1999) found that managerial knowledge, ability, and effort play significant roles in fund performance whereas Porter and Trifts (2014) showed that fund managers' experience does not guarantee good performance.
2. We followed Kacperczyk et al. (2005) in sorting the 48 industry classifications provided by Kenneth French (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data Library) into 10 sectors: consumer non-durables, consumer durables, healthcare, manufacturing, energy, utilities, telecom, business equipment and services, wholesale and retail, and finance. We also performed the analysis using the Global Industry Classification Standard (GICS) and obtained similar results. To save space, we report only the results using the 10 sectors, as in Kacperczyk et al. (2005).
3. If a fund has total net assets of $100 and invests $20 in sector 5 (energy), then $S^5 = 20\%$. If the fund invests $11 and $5 in Exxon Mobil Corp. and BP, respectively, then $W_5^1 = 55\%$ (11/20) and $W_5^2 = 80\%$ [(11 + 5)/20]. If the market capitalizations of Exxon Mobil Corp. and BP are $300 and $100, respectively, and the total market capitalization of all the listed companies in the energy sector is $10,000, then ω_5^1 is 3% (300/10,000) and ω_5^2 is 4% [(300 + 100)/10,000]. So, W_5^1 / ω_5^1 and W_5^2 / ω_5^2 are 18.33 (55%/3%) and 20 (80%/4%), respectively.
4. We named the model after Mark Carhart (1997) to acknowledge his contribution, but the momentum strategy in the mutual fund industry was studied initially by other researchers, including Grinblatt and Titman (1992, 1993, 1994); Jegadeesh and Titman (1993); Grinblatt, Titman, and Wermers (1995).
5. Details of the methodology used to form these factor portfolios can be found on Kenneth French's homepage (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html).
6. We used the log of these variables because it provided us with a better fit than a model in which these variables appear linearly.
7. 0.18% × (5.34 – 2.55) = 0.50%; the corresponding numbers in columns 2 and 3 are 0.47% and 0.39%.
8. Because only the coefficient of SQlgHoldNo is statistically significant, readers should interpret the empirical results with caution.
9. The results from using lgAdjTop2 are qualitatively similar to the results from using lgAdjTop1.
10. The results of the three other regressions are qualitatively similar and are available from the authors upon request.
11. The results of the other model specifications are available from the authors upon request.
12. Finding no detailed definitions in the CRSP database, we used definitions provided by Morningstar (http://financials.morningstar.com/fund/management.html). We treated "xxx et al." as one manager because, according to Morningstar, xxx "acts as the leader or is recognized by the fund as being the principal management player." The term *management team* is used when there are more than two people involved in the fund's management and they manage together or when the fund strongly promotes its management team aspect. The term *multiple managers* is used when more than two people are involved in the fund's management and they manage independently.

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