Estimating Portfolio Style in U.S. Equity Funds

A Comparative Study of Portfolio-Based Fundamental Style Analysis and Returns-Based Style Analysis

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Abstract

Investment style has become a prominent concept in the world of investment management. Fiduciaries who select mutual funds or money managers for retirement plans and pensions often place a high premium on consistency of investment style, and many individual investors now use style as an important decision factor. Yet little academic research has been conducted that empirically and systematically compares the two most common approaches to assessing a mutual fund's investment style, i.e., portfolio-based (fundamental) style analysis and returns-based style analysis. Each method has its proponents and detractors, yet fundamental questions about the accuracy of each approach remain open. This paper clarifies the debate over style analysis and completes the literature with an empirical analysis of the accuracy of the two methods, with respect to an actual set of open-end mutual funds. Using data from Morningstar, Inc., we tested the results of both methodologies in relation to 287 U.S. diversified equity mutual funds for six years. We find that while both portfolio-based and returns-based style analysis may be useful in certain circumstances, the portfolio-based approach is, in general, more accurate. Moreover, a key finding is that holdings-based analysis maintains its advantage even when older portfolio data are used. This result counters a frequent criticism of the portfolio-based approach.

Methodological Background

Fundamental, or portfolio-based, style analysis (henceforth, PFSA) has historically been viewed as the common-sense approach to evaluating the style composition of a mutual fund. PFSA determines a portfolio's style by an examination of the actual underlying holdings. No elaborate methodology is required to perform the analysis, only a consistent framework for defining the risk factors by which the individual securities will be categorized. Naturally, PFSA produces the highest degree of accuracy when examining a current portfolio. The biggest drawbacks to PFSA are the timeliness and cost of the data. Whereas mutual fund holdings were once obtainable only irregularly and with great difficulty, fund companies are now required to disclose holdings at least semiannually, and several well-established third-party firms collect and analyze the data. The set-up cost of tracking holdings for a substantial assemblage of funds, however, remains high.

Given the twin issues of timeliness and cost in accumulating portfolio-based data, the investment community has long sought a cheaper, more-practical substitute. In the late 1980s, William Sharpe developed an alternative method, and returns-based style analysis (RBSA) quickly gained popularity (see Sharpe [1988]). Today, the technique has become a frequently used analytical tool for pension managers, plans sponsors, consultants, and others in the world of investment management.
RBSA uses a method of constrained quadratic optimization to regress an investment portfolio's returns against a set of predetermined benchmark indexes in order to determine what Sharpe called its "effective asset mix"—essentially, the asset allocation that most closely approximates the behavior of the fund during the period over which the regression takes place (Sharpe [1988, 1992]). The parameters of the regression are constrained to be non-negative and to add up to 100%. Commercial software applications that perform Sharpe's returns-based style analysis have made the methodology widely available.

As summarized by Christopherson and Sabin [1999], RBSA "has become popular because, among other reasons, it requires few inputs, is relatively easy to perform, and yields a reasonable picture of market and style exposure at the broad-brush level" even if it is not an ideal guide for those interested in assessing a manager's style consistency.

Controlling for investment style has come to be viewed as a critical aspect of investment monitoring and decision-making in both the financial planning and pension-management communities. Money managers are often evaluated, in part, based on how well they stay within the bounds of a given investment style. In addition, investment style is often used as a proxy for risk, and the value of such an approach depends on a correct initial assessment of style. The 20 interesting papers in Coggin and Fabozzi [2003] show how the issues of style analysis and management are at once both controversial and important.

A central question is how accurately RBSA and PFSA describe the style traits of funds. Our study extends the current literature by focusing on the comparative abilities of PFSA and RBSA in assessing current and future portfolio styles. This paper finds that, while both RBSA and PFSA can in certain cases provide acceptable levels of accuracy, in general PFSA provides a greater degree of accuracy.
We conclude by discussing the practical implications of our findings for investors and fiduciaries.

Literature Review

Most previous studies on this subject have focused on RBSA alone, rather than comparing it with alternatives or examining PFSA independently. These investigations made important contributions to our understanding of the limitations of RBSA and ways of improving the method's accuracy; nevertheless, they fail to offer any empirically tested answer to the question of what degree of error can normally be expected from RBSA, whether this level is an acceptable alternative to PFSA, or when PFSA data become "too old."

Lobosco and DiBartolomeo [1997] point out that the regressors in RBSA can be collinear, thus limiting the precision of the constrained estimates. The authors also develop a formula to measure the "confidence intervals" of various style weights and recommend using daily return data, as opposed to the more common monthly data. However, they fail to display asymptotic results for the distribution of the estimates, thus the usefulness of the standard errors that they report is not clear. Kaplan [2003], in a critical analysis of RBSA, provides confidence intervals for the estimates in case the traditional RBSA coefficient restrictions are not imposed. Hardy [2003] also suggests using daily data to improve the quality and timeliness of RBSA, but fails to address the issues of computing unbiased estimates in presence of the GARCH processes that should be expected in daily return data.[i] Buetow, Johnson and Runkle [2000] look at aggregate mutual fund statistics and study the consistency of style exposures. They recommend using portfolio-specific or custom benchmarks to improve the stability of RBSA results, but do not address collinearity. Buetow and Ratner [2000] prefer PFSA to RBSA when constructing portfolios.
Despite the lack of comparative data, many of these studies assert that RBSA serves as an adequate substitute for PFSA, given the greater labor and expense involved in accumulating the portfolio data necessary to perform PFSA (Lieberman [1996]). Some go so far as to suggest that the difficulty of obtaining timely portfolio data may render PFSA less reliable than RBSA (Cummisford and Lummer [1996]).

Mayes, Jaye, and Thurston [2000] use discriminant analysis techniques to assess the consistency of RBSA with fund objective categories for a reasonably large sample of funds. They find that RBSA correctly predicts category membership for a statistically significant percentage of funds and that it "can be used as an additional method to verify more traditional techniques, such as holdings-based analysis" (Mayes et al [2000], p. 103). The authors' claims are not too practical, because a correlation of 15% results statistically significant in their sample, but implies an

unacceptably high error rate on a practical level. Also, they use traditional fund objectives, a method partly relying on a fund's stated investment practice.

Kahn [1996] performs a forward-looking, out-of-sample comparative study that is focused on the value of style analysis techniques in predicting fund risk. He finds that forecasts of the risk of a mutual fund based on the PFSA generally have a higher correlation with future risk than do forecasts based on historical performance (i.e., RBSA) for a small sample of funds—thus, the portfolio approach produces more accurate predictions of risk.

In the course of a wide-ranging discussion of mutual fund investment styles, Chan, Chen, and Lakonishok [1999] find that while in a broad sample the two methodologies give fairly close style analysis results, PFSA shows greater accuracy in predicting future returns in a smaller sample of cases where the two approaches provide materially different results.

A recent paper by de Roon, Nijman, and ter Horst [2004] compares the two approaches both theoretically and empirically. The authors examine 18 U.S.-based funds investing mainly in non-U.S. stocks and confirm that PFSA is better at predicting future portfolio compositions. However, they show, RBSA is better at forecasting future returns over a one-year period for most of the 18 funds in their sample. These results conflict with those of Kahn [1996] and with those of Chan, Chen, and Lakonishok [1999].

Data and Methodology

Our study began by selecting from Morningstar's database those diversified U.S. equity funds for which there are annual portfolios for a December 31 date from 1997 through 2002, and complete monthly performance data since January 1995. This resulted in a total sample of 287 funds (multiple share classes were eliminated).[ii] We computed portfolios for each fund using a PFSA of each as of December 31 for all years from 1997 to 2002. We identified each individual security in the portfolio according to its appropriate style category: cash, bonds, international equity, or one of six style subcategories for U.S. equities assigned to a corresponding Russell Style Index from the Frank Russell Company (see Exhibit 1). In each instance, we classified securities using Russell's subcategories as of December 31 of that year.[iii]

Exhibit 1. Style Categories and Corresponding Benchmark Indexes Used Both in RBSA and PFSA

Sub-Asset Class	Index
U.S. Large Growth	Russell Top 200 Growth
U.S. Large Value	Russell Top 200 Value
U.S. Mid-Cap Growth	Russell Mid Cap Growth
U.S. Mid-Cap Value	Russell Mid Cap Value
U.S. Small Growth	Russell 2000 Growth
U.S. Small Value	Russell 2000 Value
International Equity	MSCI EAFE ND
Bonds	Lehman Brothers Aggregate
Cash	90-day Treasury Bill

Next we performed the analogous RBSA for the 287 funds as of year-end 1997 through 2002 using a constrained quadratic regression following Sharpe's [1988] recommended method, which requires three years of monthly return data. The same Russell indexes that were used with the PFSA were chosen as regressors for the U.S. equity part. These indexes limit the most commonly identified problems of index selection and insufficient coverage of asset classes, and to some extent multicollinearity. In addition, Russell indexes are frequently used as benchmarks for mutual fund managers, making them appropriate for this test case. Finally, the Russell indexes (unlike, for example, the style indexes of Standard & Poor's), are comprehensive, thereby permitting a high hit rate for holdings within

the individual mutual funds (that is, the percentage of securities found in both the fund and the index). In cases where a stock crossed two style categories, its weighting was distributed according to a ratio assigned by Russell.[iv] Extending the study back to 1997 allows us to test the efficacy of RBSA on a current portfolio, its out-of-sample predictive value up to three years from the baseline portfolio, as well as its comparative value against PFSA for several overlapping periods.

Exhibit 2. Average Portfolio Exposures in the sample, by Year and Asset Class

Asset Class	Technique	1997	1998	1999	2000	2001	2002
	PFSA	18.2%	22.0%	23.2%	19.3%	23.4%	24.9%
Large Growth	RBSA	18.6%	16.7%	20.0%	20.8%	20.3%	18.9%
	PFSA	11.1%	11.3%	13.9%	20.8%	18.7%	19.3%
Large Value	RBSA	13.5%	15.4%	16.0%	16.5%	15.7%	18.8%
	PFSA	12.8%	12.6%	11.7%	9.8%	12.9%	16.0%
Mid Growth	RBSA	20.7%	21.0%	16.9%	12.7%	14.4%	15.0%
	PFSA	10.7%	10.9%	11.8%	15.6%	13.9%	13.2%
Mid Value	RBSA	9.3%	9.9%	12.0%	18.5%	18.7%	18.0%
	PFSA	8.8%	9.3%	9.1%	7.6%	8.3%	7.9%
Small Growth	RBSA	16.7%	15.6%	14.1%	13.5%	10.8%	11.1%
	PFSA	6.4%	5.9%	5.4%	7.0%	6.4%	5.5%
Small Value	RBSA	8.9%	10.5%	12.2%	9.9%	9.5%	8.6%
	PFSA	3.9%	3.3%	4.5%	3.4%	3.1%	3.3%
Foreign	RBSA	4.0%	5.1%	3.7%	3.8%	5.3%	2.9%
	PFSA	1.1%	0.9%	0.8%	0.8%	0.7%	0.7%
Bonds	RBSA	3.9%	3.6%	2.9%	2.2%	2.7%	3.9%
	PFSA	4.8%	4.6%	4.1%	5.0%	4.3%	3.8%
Cash	RBSA	4.3%	2.3%	2.2%	2.1%	2.7%	2.8%
	PFSA	22.1%	19.3%	15.4%	10.7%	8.2%	5.3%
Other	RBSA	N/A	N/A	N/A	N/A	N/A	N/A

Exhibit 2 shows the average asset allocations, as measured by PFSA and RBSA, for the 287 funds in the sample at the end of each of the years from 1997 to 2002. Unsurprisingly, the estimated exposures for each of the seven equity sub-asset classes and three fixed-income sub-asset classes differ. "Other," an extra "asset class," appears for PFSA, which captures all of the securities that were not directly mapped to any of the indexes used for PFSA: mostly, this amounts to micro-cap stocks (not considered by the Russell indexes), equities of small foreign companies, and money market mutual funds that were held instead of short-term securities (note that for this paper we used a simplified method and not the sophisticated and more accurate approach used by Morningstar in its products; 92 of the 1,722 portfolios in our sample —about 5%—had more than 30% in "Other." In the Morningstar production database, 5% of the distinct portfolios have more than 10% in "Other." Assigning securities categorized as "Other" with more sophisticated methods, such as Morningstar's, would increase the reliability of the PFSA approach, and thus we believe that our process tends to conservatively understate the accuracy of PFSA. With six years of data in hand that show both PFSA and RBSA of a substantial sample of diversified equity mutual funds, we are in a position to address the questions most important to investors: how accurate is each methodology in its estimation of portfolio style traits, what degree of error can typically be expected, in what circumstances is each method best used, and how do the two methods stack up against one another?

Results

Assessing the Style of Current Portfolios

One of the basic questions an investor might ask is how well PFSA and RBSA evaluate the style exposure of a fund's current portfolio. This is to some extent a loaded question because one may expect the PFSA of a current portfolio to be the correct one.[v] RBSA, by definition, is a constrained estimate of a portfolio's past and current exposures, but the output of RBSA is frequently used as proxy for a fund's current positioning.

The question then becomes, since RBSA is an estimate, what is the error term? Regarding PFSA, at what rate does its quality degrade over time? Since the most current portfolio may not always be available to conduct PFSA, it is instructive to test an alternative, such as a one-year-old portfolio. Thus, to answer both questions regarding style analysis of current portfolios—the relative accuracy of a "current" RBSA and a year-old portfolio—we compare current PFSA with both current RBSA and past PFSA.

Because the portfolios under consideration are diversified U.S. equity funds, our primary interest throughout this study is in the results for the domestic stock portions of the portfolios. To assess these results, we use two different methods for measuring accuracy: correlation and mean absolute deviation.

Correlation expresses in percentage terms the degree to which the holdings of a test portfolio match an actual baseline portfolio. For example, to compare large growth style exposure of RBSA 2002 with a portfolio of PFSA 2002, we take the percentage of assets attributed to large growth in RBSA 2002 for a fund and determine their fit with the large growth component of PFSA 2002 for the same fund, and similarly for all other funds in the sample, to compute a correlation. We then repeat this process for each of the remaining sub-asset classes. Finally, we repeat the process for all years, and average the correlations for the six years for each of the sub-asset classes. These are the numbers (the higher correlation, the better) reported in Exhibit 3.

Exhibit 3. Asset Class Correlations

CORRELATIONS	Large Growth	Large Value	Mid Growth	Mid Value	Small Growth	Small Value	Foreign	Bonds	Cash
RBSA, PFSA	86.1%	76.1%	68.5%	59.9%	76.8%	82.3%	34.5%	46.7%	22.5%
PFSA, $PFSA_{-1}$	94.0%	92.7%	88.0%	83.7%	94.1%	94.4%	83.5%	71.9%	42.0%
RBSA, $RBSA_{-1}$	94.2%	85.8%	84.6%	79.9%	93.8%	89.9%	63.5%	69.3%	67.3%
PFSA, $PFSA_{-2}$	89.9%	87.1%	77.5%	71.0%	88.7%	89.9%	78.4%	61.6%	31.9%
RBSA, $RBSA_{-2}$	85.8%	76.3%	65.1%	69.4%	87.0%	84.8%	40.1%	46.4%	41.5%
PFSA, $PFSA_{-3}$	88.6%	86.2%	67.5%	62.4%	84.9%	87.7%	77.8%	42.4%	34.8%
RBSA, $RBSA_{-3}$	76.1%	67.6%	48.4%	54.7%	80.5%	77.5%	8.8%	29.2%	17.9%
RBSA, $PFSA_{-1}$	87.8%	75.4%	72.1%	67.4%	77.8%	82.3%	35.4%	50.5%	23.3%
PFSA, $RBSA_{-1}$	84.5%	73.5%	61.3%	53.6%	74.9%	80.6%	35.3%	40.6%	15.4%
RBSA, $PFSA_{-2}$	86.0%	74.2%	67.9%	68.6%	77.9%	81.1%	31.5%	44.1%	16.8%
PFSA, $RBSA_{-2}$	83.0%	71.0%	52.8%	46.4%	73.0%	79.7%	36.5%	33.3%	14.2%
RBSA, $PFSA_{-3}$	81.3%	74.4%	62.9%	65.9%	76.7%	77.5%	19.7%	33.4%	10.7%
PFSA, $RBSA_{-3}$	81.0%	68.8%	45.2%	38.6%	72.5%	79.5%	38.6%	21.5%	13.5%

Let us look at the first row of Exhibit 3. The correlations between current RBSA and current PFSA range from strong (86.1% for large growth) to weak (22.5% for cash). This suggests that the two approaches often have contrasting results. Correlation figures offer a good first-line assessment of error, but to look at the material impact of the estimation "error," it is helpful to examine absolute deviation alongside correlation. Absolute deviation—the unsigned difference between the style category exposures of a test portfolio and the baseline portfolio—is a relevant and intuitive measure because, on a practical level, investors and consultants are more likely to think in terms of the absolute deviation of an asset class from its prescribed allocation than in percentage terms. A 75% correlation may look acceptable at first, for example, but if it results in a plus-or-minus 15-percentage point deviation from a style target of 20%, this correlation quickly becomes less acceptable and the impact of the error is economically very significant.

Exhibit 4. Asset Class Mean Absolute Deviations

DEVIATIONS	Large Growth	Large Value	Mid Growth	Mid Value	Small Growth	Small Value	Foreign	Bonds	Cash
RBSA, PFSA	8.4%	8.9%	11.1%	11.3%	9.0%	6.8%	4.4%	3.0%	4.9%
PFSA, $PFSA_{-1}$	5.2%	4.4%	4.4%	4.3%	2.6%	2.0%	1.9%	0.6%	3.4%
RBSA, $RBSA_{-1}$	**4.8%**	6.2%	7.1%	6.8%	4.6%	4.8%	3.3%	2.5%	**2.2%**
PFSA, $PFSA_{-2}$	6.9%	6.7%	6.2%	6.1%	3.4%	2.7%	2.3%	0.8%	3.7%
RBSA, $RBSA_{-2}$	7.8%	8.4%	11.3%	9.6%	7.1%	6.2%	4.3%	3.6%	3.1%
PFSA, $PFSA_{-3}$	6.2%	8.3%	6.9%	6.8%	4.0%	3.0%	2.3%	0.9%	3.8%
RBSA, $RBSA_{-3}$	10.0%	10.1%	15.0%	12.8%	9.0%	7.4%	5.5%	4.4%	4.0%
RBSA, $PFSA_{-1}$	7.9%	9.0%	10.5%	11.3%	8.5%	6.9%	4.5%	2.7%	4.9%
PFSA, $RBSA_{-1}$	8.9%	9.4%	12.2%	11.9%	9.4%	7.0%	4.5%	2.9%	5.0%
RBSA, $PFSA_{-2}$	8.6%	9.1%	10.5%	11.8%	8.3%	7.1%	4.6%	2.7%	5.1%
PFSA, $RBSA_{-2}$	9.2%	9.8%	13.5%	12.3%	10.1%	7.1%	**4.2%**	3.1%	**4.9%**
RBSA, $PFSA_{-3}$	9.8%	9.4%	11.1%	12.8%	8.1%	6.8%	5.1%	2.9%	5.2%
PFSA, $RBSA_{-3}$	9.8%	10.5%	14.9%	**12.5%**	10.4%	7.4%	**4.1%**	3.5%	**5.1%**

Therefore, in Exhibit 4 we examine the statistics for mean absolute deviation from the baseline portfolio (lower average errors are better, and the instances where RBSA has a lower error than PFSA are indicated in bold). In the case of current portfolios, we can see that the deviations between current RBSA and current PFSA are large, and range between 3% (bonds) and 11.3% (mid-cap value stocks). This means that, on average in our sample, the difference between a year's percentages of portfolio assigned by RBSA to a certain fund's mid-value allocation and that assigned by PFSA to the same fund's mid-value allocation is 11.3% of the portfolio—a large difference indeed.

Both of our tests show that RBSA and PFSA often diverge from each other in a material way. This means that at least one method (perhaps both) is not very accurate in assessing current portfolio style.

Stability and Forecasting Power

How suitable is a relatively old analysis in depicting a fund's current style? This question can be clearly rephrased as: how accurate is a current analysis in predicting the future risk factor exposures of the fund? Let us look at the first three rows of data in Exhibit 3. The correlations between current PFSA and PFSA computed one year ago (this is the meaning of the –1 subscript in the labels of the table's rows) are substantially higher than those between current RBSA and current PFSA. For domestic stock style categories, no correlation is lower than 84.6% (mid-cap value), and the highest is 94.2% (small value).

These correlations are generally equal to or higher than those of RBSA compared to one-year-old RBSA. Therefore, it is reasonable to say that, as measured by correlation, using PFSA for a one-year-old portfolio results in only a marginal decline in value for estimating the style of a current portfolio. Moreover, a one-year-old PFSA (see row RBSA, $PFSA_{-1}$) has about the same correlation to current RBSA as a current PFSA (see the first row of Exhibit 3), which confirms the stability over time of PFSA. Clearly, this is a result of remarkable practical relevance, as it addresses the concern that PFSA may be unreliable if based on a relatively old portfolio.

The focus of this paper is on U.S. equity, and not foreign equity or fixed income, and as explained in the Data section, we used a rather unsophisticated method that resulted in PFSA allocations to Other, thus probably not using the full potential of PFSA. Still, one notices that the ability of one-year-old PFSA in forecasting the current exposure to cash is low (correlation is 41.9%) while that for RBSA is better (third row of the table: 67.2%); for foreign stocks, "last year's" PFSA produces visibly higher correlations (78.0%) than RBSA, which scores less well (63.4%).[vi] Interestingly, we see that the forecasting ability of past RBSA deteriorates more quickly than that of past PFSA: except for cash in the current vs. two-year-old case (where RBSA has a correlation of 41.5% compared to 31.9% for PFSA), in every other case past PFSA has higher correlation with current PFSA than past RBSA has with current RBSA.

These results confirm the results for correlations, namely, that using "old" RBSA provides significantly less accurate estimates of a fund's current RBSA than using old PFSA to estimate current PFSA. The result does not say which technique is

more accurate, therefore, but it confirms many empirical studies suggesting that PFSA is more stable than RBSA. As other authors find (e.g., Cristopherson [1995]), RBSA appears to give style estimates that change widely over time. This is not new, but still puzzling, as one recalls that 24 of the 36 monthly returns used to compute "this year's" RBSA were also used in computing "last year's" RBSA, and therefore one would expect more consistency.

An analysis of the mean absolute deviations in Exhibit 4 confirms these findings. Clearly, exposures may also change because fund managers may change strategy. In this case, one expects PFSA to have an advantage, as it is based only on the latest portfolio information, and not on an average of the last 36 monthly returns. Interestingly, PFSA weights are more highly correlated to past PFSA weights than their RBSA cousins, thus suggesting that most fund managers seldom change style dramatically and confirming the relative instability of RBSA, which is not unusual for a numerical optimization.

Cross-checking Older Portfolios

Our results thus far indicate that an old portfolio used for PFSA of a current portfolio provides better results than an old RBSA to analyze a current portfolio; that RBSA portfolio estimates appear more volatile; and that PFSA results often differ from RBSA results. Logically, the next question is whether PFSA is a more accurate estimator of a fund's future portfolio than RBSA. To answer this question, we tested out of sample the results of old RBSA against the current PFSA and the old PFSA against current RBSA.[vii]

This test is reasonable because RBSA gives equal weight to each of the 36 monthly returns, thus one can argue that on average the returns-based information is 18 months old. The absolute deviations (lower part of Exhibit 4) show that in the mid-cap area both methodologies depart significantly from the more recent results, with double-digit error terms for both (but RBSA generally higher). Yet both methodologies in general perform adequate estimates. This is interesting because the correlations (lower part of Exhibit 3) are very low for the Foreign asset class, but the deviations are small. This confirms our suggestion that a tiny change (perhaps even due to rounding) lowers the correlations with little or no material effect for the actual investor because the funds in the sample have limited foreign equity shares.

The more meaningful finding is that PFSA performs equally as well as RBSA even when the latter determines the baseline portfolio; the advantage increases when a current portfolio is determined through holdings-based analysis.

Conclusion

Our paper constitutes the first systematic, empirical investigation of the relative merits of two widely used methods of measuring a portfolio's style.

By extending the current literature on the subject, this study provides practitioners with important insights. A comparison of the two methodologies of holdings-based style analysis (PFSA) and returns-based style analysis (RBSA) demonstrates that, whether measured by correlation or absolute deviation, RBSA produces significantly weaker results than does PFSA based on a one-year old portfolio. The advantage to PFSA persists even when portfolios older than one year are used, and even when RBSA provides the baseline style composition, and are based on a methodology that is likely to understate the accuracy of PFSA.

This is not to say that RBSA has no value, only that its results must be considered cautiously, and they may be more useful in some contexts than others. We found, for instance, that the deviation of RBSA estimates is far greater among small-cap and mid-cap U.S. equities. Therefore, it is reasonable to suggest that style analysis is less useful for groups of mutual funds that concentrate on small-cap stocks. (This point implies that some level of *a priori* fundamental research is necessary to run the style analysis in the first place). With fund types for which no portfolio data are available, such as hedge funds, RBSA is the only available option, even if picking the appropriate regressors may be difficult. We can also speculate that RBSA would prove advantageous in the case of mutual funds whose managers made substantial use of options or other derivatives. In some cases, neither PFSA nor RBSA is especially reliable. This is true, for instance, of funds that shift styles frequently. Investors would be well advised to view results for either methodology with caution when these conditions obtain. As an aside, using daily instead of monthly data for RBSA is problematic because it introduces high-frequency noise that the regression is not designed to address (this point deserves further study).

However, in most cases where holdings data are available, our study supports the claim that PFSA is the preferred methodology. Portfolio data do not need to be absolutely current to provide an acceptable degree of predictive efficacy. A further advantage of PFSA is that only one year's worth of data are needed to perform an acceptable calculation, as opposed to the three years' data needed to run RBSA. This has the potential of making PFSA more affordable for consultants weighing the costs of each approach, particularly when new funds are involved.

While our study does not address the question of how well the two approaches to current portfolio style predict future mutual fund returns—a potentially important question for those who view style as a proxy for risk—existing studies (Kahn [1986] and Chan *et al.* [2001]) show that PFSA has greater accuracy than RBSA when analyzed from this perspective as well (while de Roon *et al.* [2004] disagree). Therefore, the portfolio-based approach to style analysis is likely to be the method of choice in most situations. In the future, our research will address this topic of the risk implications of style exposure.

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Endnotes

[i] Rob Engle's Nobel Prize lecture, explaining ARCH and GARCH, can be found online at http://www.nobel.se

[ii] Our study does not make any adjustments for selection or survivorship bias, but we do not envision that doing so would affect the results in any meaningful way. A previous version of this paper, using a sample of over 500 funds for a shorter time period, confirmed our results.

[iii] We thank Russell/Mellon Analytical Services for providing annual portfolio compositions for all indexes.

[iv] Certain stocks classified by Russell into its style indexes may contain a mixture of the price and growth characteristics associated with growth or value. In such cases, Russell weights the stock according to its combined features (e.g., 70% growth, 30% value). When we encountered cases of such stocks in our study, we distributed their market caps across the indexes based on the ratio designated by Russell.

[v] This may not always be the case, however, since the individual securities within a portfolio may differ from their Russell categorization. The total assets of a company such as Microsoft, for example, may in fact be allocated 10% to cash—but what about the net assets? The difficulty and labor required to track net assets within this information would make it an impractical addition to the portfolio-based method.

[vi] Many foreign-based multinational companies have behavioral characteristics that during some periods tend to mimic those of large U.S. stocks, leading RBSA to frequently misattribute international stock performance. Multicollinearity is clearly present, and it is possible that improved index selection could partially correct the problem. An additional problem is that with only a small share of the portfolio in cash and bonds (the average total in Exhibit 2 does not generally exceed 6%), minor numerical changes in style composition produce percentage shifts that are sufficient to lower correlations.

[vii] The same data comparing current and older style analysis results could also be used, in reverse, to assess each method's relative efficacy as an attribution measurement for a mutual fund's past style behavior.