

# The Inconsistency of Return-Based Style Analysis

*And its implications.*

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**W**hat is an investment style? How is an investment style defined? Is investment style one-dimensional or multidimensional? These are important questions that must be addressed before a comprehensive style analysis can be performed.

Many investment professionals equate style with the various commercially available indexes, and then use these indexes to analyze a portfolio manager's investment style. The implications of this process are far-reaching from perspectives of both portfolio manager and plan sponsor.<sup>1</sup>

The desire to categorize an investment philosophy into a particular style is understandable. If the categorization is accurate, it would allow decision-makers to correctly assess the relative performance of a portfolio manager. It is unlikely that categorization can be correct in most cases, since the process is methodologically far more difficult than most investment professionals realize.

Michaud [1998] addresses style identification by introducing many accepted definitions of a value stock. He suggests that perhaps the best approach is to use a multidimensional definition. This line of reasoning implies that the same multidimensional definitions should be valid for the broad category of growth stocks.

The findings of Brown and Mott [1997] reinforce Michaud's contention. They find that indexes for the same style behave differently for a number of reasons (e.g., fundamentally different definitions for a specific style, index construction, universe of securities from which the index is chosen, and rebalancing frequency).

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These findings should lead one to conclude that using an index based on a univariate definition to analyze an investment style is seriously flawed. As many investment professionals know, however, this is what typically occurs in practice.<sup>2</sup>

We provide evidence that most results from traditional return-based style analysis are inconsistent and too dynamic to be used in a meaningful way (see Sharpe [1988, 1992]). We conjecture that the reason is the unavailability of a proper definition of style, not a fundamentally flawed methodology. Our presentation is not intended as a condemnation of return-based style analysis. All investment style analysis methodologies suffer from the same problem. It is doubtful that such an all-encompassing multidimensional definition will ever exist, so all style analysis must be applied with caution.

How should return-based style analysis be used? We show that when the investment style can be completely and correctly captured by a set of asset classes used as independent variables, the results are stable and consistent. This implies that style analysis can be employed whenever a manager indexes a portfolio to specific benchmarks and actively allocates across the different benchmarks.

Suppose a manager has a long-term strategic asset allocation strategy that indexes the assets against well-defined benchmarks like the S&P 500 and the Lehman Brothers Bond Index, and then has a tactical asset allocation strategy that allocates assets either between these benchmarks or across other well-defined benchmarks. Under this framework, the style analysis will properly evaluate the investment philosophy because the asset classes (or independent variables) used in the analysis completely describe the manager's strategy.

We are not suggesting that the only way to use return-based style analysis is to base a strategy on well-defined indexes and then evaluate asset allocation strategies.<sup>3</sup> Portfolio-specific benchmarks could be used instead of the commercially available indexes.

## A PERSPECTIVE

There are two prominent schools of thought on the application of return-based style analysis. Sharpe [1988, 1992] and Tierney and Winston [1991] advocate its use to analyze the asset mix of a portfolio manager. Sharpe suggests that return-based style analysis is the key to determining a manager's effective asset mix, and that it can be used to determine how effective a manager is

at actively managing the portfolio. We believe this to be an overly ambitious conclusion.

Christopherson [1995] criticizes this approach primarily on statistical grounds and offers an alternative called a style classification system. Unfortunately, he does not illustrate the effects of his statistical reasoning on actual return-based style analysis. His highly critical conclusions about return-based style analysis appear to be stronger than his results can justify.

Our findings suggest that the efficacy of return-based style analysis is somewhere between these two divergent perspectives.

Bogle [1998] enters the debate on a much less quantitative level. He suggests that the style classification system introduced by Morningstar can be used to show that passive investing is superior to active management in all style classes. This less quantitative approach may be superior since it accepts the style definitions as given and circumvents the need to develop a multidimensional definition of style. For his findings to be applicable, however, one would have to invest using the Morningstar definitions of style.

## THE ELUSIVE CONCEPT OF INVESTMENT STYLE

Placing assets into the proper style "bucket" is not an easy exercise. What defines a growth stock or a value stock? Where do we draw the line between a large-capitalization stock and a small-capitalization stock? Even more elusive is defining the difference between an aggressive growth stock and a growth stock. There are many alternative and often conflicting answers to these questions. The fundamental problem with trying to categorize assets is that a single asset may exhibit characteristics that satisfy more than one style classification.

Moreover, a portfolio manager may use a financially defensible definition that differs from those used to create widely accepted style indexes. Using these style indexes to evaluate the manager is then problematical, because the results will not truly represent the manager's underlying investment style.

From personal experience, we are all too aware of using a definition of style only to have the return-based style analysis suggest that our portfolio is not what we claim or advertise. Christopherson [1995] blames return-based style analysis for the inconsistent results. While this may be a valid conclusion, we suggest an alternative interpretation. We believe that the inconsistency

problem is largely due to the many plausible definitions of style and the many dimensions of style.

## **THE FUNDAMENTAL PROBLEM WITH RETURN-BASED STYLE ANALYSIS**

Return-based style analysis requires two sets of inputs. The dependent variable (DV) is a return series for the portfolio or asset under evaluation. The independent variables (IV) are a set of variables that are used to explain the dependent variable. It is not difficult to understand why this approach may have problems. The DV may be based on a style definition that cannot be captured by any available index that would be used as an independent variable. Additionally, the IVs may be highly correlated with each other. We believe that these problems are the cause for the wildly fluctuating style exposures that have been experienced.

Typically, return-based style analysis uses a set of time series returns of various indexes as the IVs and the corresponding portfolio returns as the DVs. Now suppose a portfolio manager uses a fundamentally different definition of style from the indexes used to evaluate the performance of the manager's portfolio. For example, assume the manager uses a combination of sales growth, growth in earnings expectations, and positive earnings surprises as the definition of growth. The returns on this portfolio would be analyzed using the returns on standard indexes (i.e., the Standard & Poor's/BARRA 500 Growth and Value indexes and the Russell 2000 Growth and Value indexes).

This style analysis would be interpreted by many researchers to correctly attribute the returns on the portfolio to four different equity styles: large-cap growth, large-cap value, small-cap growth, and small-cap value. Yet these indexes use the price/book ratio as the only criterion to separate stocks into growth stocks and value stocks. The portfolio manager may be dismayed to find that the results from the return-based style analysis show the portfolio to have a very large value component.

A further criticism relates to the IVs. Since definitions of style are ultimately subjective, different consultants use alternative index returns as the IVs and obtain strikingly different results. The issue is exacerbated when consultants use proprietary return series to perform their analysis. Contributing to the instability of return analysis is the fact that index composition changes through time. As a consequence, the results from return-based style analyses have been suspect at best.

These observations certainly suggest that application and interpretation of return-based style analysis must be approached with great care. The portfolio manager must be comfortable with the analysis. She must ensure that the returns used as the IVs are truly representative of her investment philosophy. The consultant must also be aware of the potential misuse of return-based style analysis. DiBartolomeo and Witkowski [1997] conclude, not surprisingly, that many mutual funds are misclassified according to results from return-based style analysis.

Our findings suggest that the results from return-based style analysis should not be used to classify anything until the variable definition and data quality problems are addressed.

## **EMPIRICAL EXAMINATION OF THE STABILITY OF RETURN-BASED STYLE ANALYSIS**

We have developed a number of examples that illustrate how return-based style analysis should and should not be applied. Return-based style analysis gives inconsistent results whenever the investment objective of the portfolio has room for subjectivity. The best application of return-based style analysis occurs when the portfolio investment objective is well understood and the independent variables (or asset classes) represent the investment style objective accurately.

In order to test the stability of return-based style analysis, we perform such an analysis on several mutual funds and mutual fund aggregates for a three-year rolling period.<sup>4</sup> We use asset class definitions similar to those in Sharpe [1992]. A description of our asset classes is provided in Exhibit 1. We use monthly total return data from January 1985 through September 1998.

Exhibit 2 shows the results from return-based style analysis of the Fidelity Select Technology Fund using monthly returns and a three-year rolling period. Exhibit 3 illustrates the results for the same fund, except that the Russell 2000 Growth and Value indexes are replaced with the BGI Small Cap Growth and Value indexes. Since the Russell 2000 Growth has a correlation with the BGI Small Cap Growth of 0.99 over this period, we would expect the results to be essentially identical, except for replacing the Russell 2000 Growth exposure by the BGI Small Cap Growth. We see, however, that the style exposures change dramatically.<sup>5</sup>

This characteristic of return-based style analysis is very problematical since interpretation of the differ-

**EXHIBIT 1**  
**ASSET CLASSES USED FOR STYLE ANALYSIS**

Class Name	Description
BGI Small Cap Growth and Value <sup>a</sup>	The securities in the Small-Capitalization Index are sorted between Growth and Value based on their price/book ratios, so that the market capitalization of Small Value and Small Growth are approximately equal. The Small Growth index is composed of 558 securities as of March 1996, representing 4.5% of the BGI U.S. Equity Market. The Small Value index is composed of 602 securities as of March 1996, representing 4% of the BGI U.S. Equity Market. BGI U.S. Equity Market Index is composed of S&P 500 plus exchange-traded and OTC U.S. common stocks.
MSCI EAFE ex-Japan <sup>b</sup>	Australia, Austria, Belgium, Denmark, Finland, France, Germany, Hong Kong, Ireland, Italy, Malaysia, Netherlands, New Zealand, Norway, Singapore, Spain, Sweden, Switzerland, United Kingdom.
MSCI Japan <sup>b</sup>	Japan
SB Non-U.S. 1+ Yr Government	The Salomon Brothers World Government Bond Index is a market-capitalization weighted benchmark that tracks the performance of fixed-rate sovereign debt issued in the domestic market in the local currency with at least one-year maturity. The market-capitalization weighting is updated once a month. Cash flows are reinvested at local short-term interest rate from actual scheduled payment date of cash flow through end of reporting period. Country eligibility is determined based on market capitalization and investability criteria. Once a market satisfies these criteria, it is added to the WGBI at the end of the following quarter. A market exits the index when the market capitalization of eligible issues falls below one-half of all of the entry criteria levels for six consecutive months, and it will be removed at the end of the following quarter. Barrier to entry is considered a reason for exclusion from the index.
Russell 2000	The Russell 2000 <sup>®</sup> Index is a small-cap index consisting of the smallest 2,000 companies in the Russell 3000 Index, representing approximately 11% of the Russell 3000 <sup>®</sup> total market capitalization.
SP MidCap 400	The S&P MidCap 400 is designed to measure the performance of the middle-capitalization sector of the U.S. equities market. This market-capitalization weighted index was created in June 1991 and consists of 400 domestic stocks from the NYSE, Nasdaq, and Amex. Each stock added to the index must represent a viable enterprise and must be representative of the industry group to which it is assigned. The market price of each security in the index must be responsive to changes in industry affairs. Aggregate market value of the stock and its trading activity are important considerations in the selection process.  Before June 1991, performance data were calculated by taking stocks now in the index and tracking them backward, with dividends, as long as there are prices reported. No attempt is made to recreate the index and determine what stocks “might have been” in the index five or ten years ago. Dividends are reinvested on a monthly basis, while the index is rebalanced only as needed.
SP/BARRA 500 Growth and Value	The S&P/BARRA 500 Growth and S&P/BARRA 500 Value indexes are constructed by dividing the stocks in the S&P 500 index according to price-to-book ratios. The indexes are market-capitalization weighted, and their constituents are mutually exclusive.
LB Mortgage	Lehman Brothers (LB) Mortgage-Backed Securities Index includes fifteen- and thirty-year fixed-rate securities backed by mortgage pools of the Government National Mortgage Association (GNMA), Federal Home Loan Mortgage Corporation (FHLMC), and Federal National Mortgage Association (FNMA).

**EXHIBIT 1  
CONTINUED**

Class Name	Description
LB Corp	Lehman Brothers (LB) Corporate Bond Index includes all publicly issued, fixed-rate, non-convertible investment-grade dollar-denominated, SEC-registered corporate debt. Included among Yankees is debt issued or guaranteed by foreign sovereign governments, municipalities, government agencies, or international agencies.
LB IT and LT Gvt	Lehman Brothers (LB) IT Government Index is composed of agency and Treasury securities with maturities up to ten years; similarly, the LB LT is composed of agency and Treasury securities with maturities of longer than ten years.
SB U.S. 3 Mo. TBill	Salomon Brothers (SB) Treasury Bill Index.

<sup>a</sup>The BGI Barclays database is screened to remove: preferred stock, rights, warrants, limited partnerships, trusts, closed-end mutual funds, pink sheet stocks, stocks priced below \$1 per share, and stocks that do not trade regularly. It is a market "float" index made up of all the stocks in exchange-traded and OTC U.S. common stocks. Starting in January 1993, shares outstanding are adjusted for significant corporate and private ownership. All indexes are updated semiannually, although new constituents may be added as necessary. Stocks are included in style indexes on the basis of their market capitalization, utility status, and the price/book value ratio.

Ibbotson Associates calculates the six composite series (total return and market value for each) based on methodology from BGI Barclays. A composite market value is the sum of the individual component market values. A composite total return is a market value-weighted sum of the individual component total returns.

<sup>b</sup>Morgan Stanley Composite Indexes (MSCI) are designed to reflect the performance of the entire range of stocks available to investors in each local market. Stocks are chosen for the indexes by criteria as follows:

1. 60% coverage of the total market capitalization for each market.
2. The companies replicate the industry composition of each global market.
3. Stocks are a representative sampling of large-, medium-, and small-capitalization companies from each local market, taking into account the stocks' liquidity.
4. Stocks of non-domiciled companies, investment trusts, and mutual funds are not eligible for country indexes.
5. Companies with restricted float due to dominant shareholders or cross-ownership are avoided.

Each stock in the local index is weighted by market capitalization. Likewise, each country in a regional index is proportionally weighted by its total market capitalization in U.S. dollars.

Source: Ibbotson Associates 1998-1999.

ent style exposures will lead to considerably different conclusions. Since either set of independent variables can be defended, which one is correct? Return-based style analysis cannot be effectively applied to a fund whose investment philosophy is not properly captured by the IVs. This is a very strong argument for portfolio-specific benchmarks that properly capture both the security universe and the investment style of the portfolio manager.

Exhibit 2 shows that the exposures are primarily to the Russell 2000 Growth, S&P Midcap 400, and the S&P/BARRA 500 Growth. As expected, Exhibit 3 shows that the fund has a large exposure to the BGI Small Cap Growth index, yet the exposure to both the S&P Midcap 400 and the S&P/BARRA 500 Growth has increased significantly. In addition, the volatility of the exposures is much greater in Exhibit 3 than in Exhibit 2.

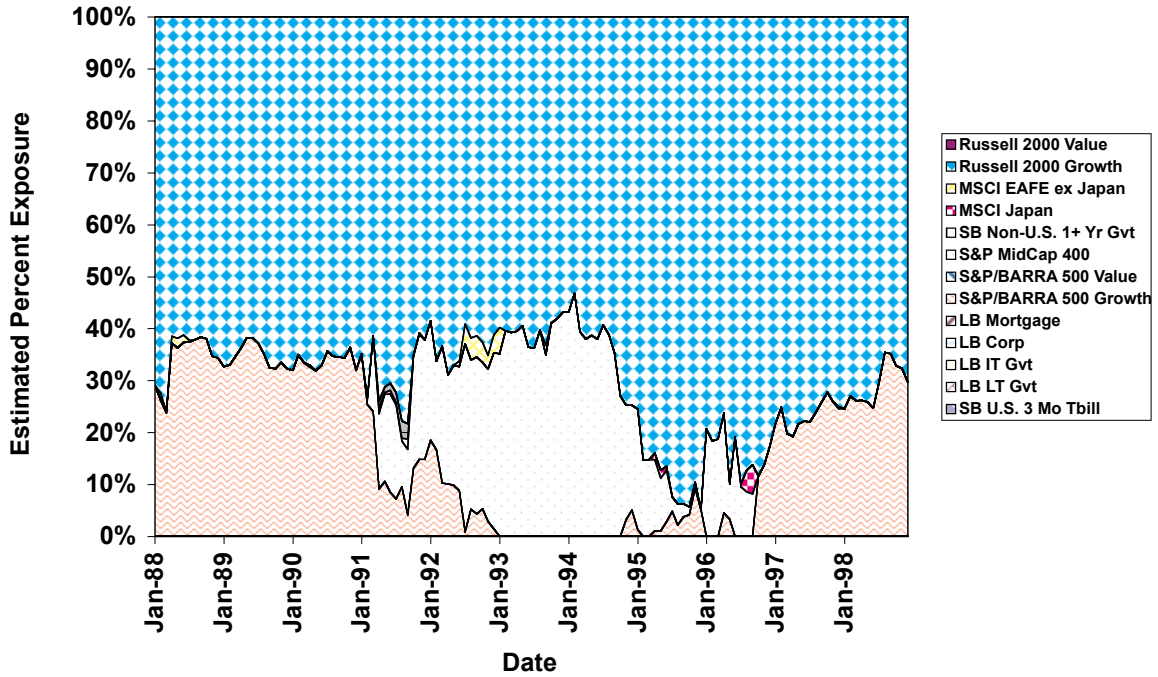
There is nothing unique about the Fidelity Select

Technology Fund. We find similar results for many other individual funds and mutual fund aggregates. Consequently, literal interpretation of return-based style analysis is questionable.<sup>6</sup>

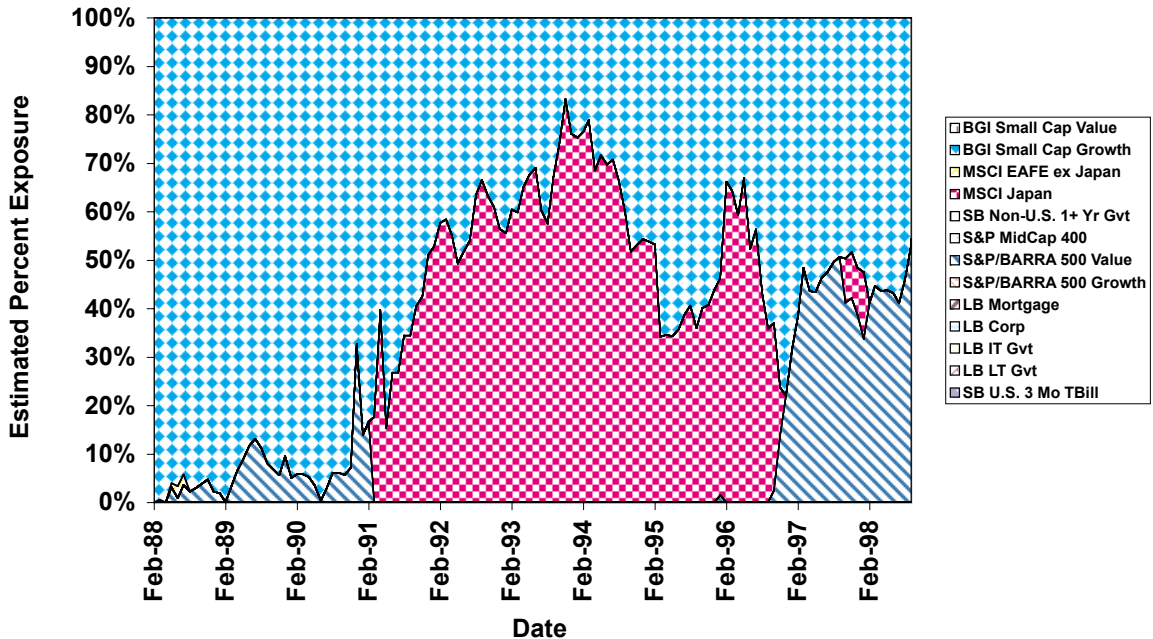
Exhibits 2 and 3 illustrate two disturbing properties of return-based style analysis. The first property concerns the volatility of the exposures through time. To suggest that the manager changed investment philosophy substantially over this period is not plausible. The second property concerns the fact that what most would consider similar sets of IVs result in drastically different exposures. This is an example of how alternative style definitions will provide different results. This will likely have consequences for how a portfolio manager's performance is evaluated and, if the manager is fired, how a substitute manager will be selected.

Defenders of return-based style analysis may say that

**EXHIBIT 2**  
**THREE-YEAR ROLLING STYLE FOR FIDELITY SELECT TECHNOLOGY FUND**



**EXHIBIT 3**  
**THREE-YEAR ROLLING STYLE FOR FIDELITY SELECT TECHNOLOGY FUND WITH BGI**



the style analysis in Exhibits 2 and 3 is not appropriate since the Fidelity Select Technology Fund is a U.S. equity fund. They might claim that at most four styles should be included in a return-based style analysis for the fund: large-cap growth, large-cap value, small-cap growth, and small-cap value.

Exhibit 4 shows just such a style analysis using the Standard & Poor's/BARRA 500 Growth and Value indexes and the Russell 2000 Growth and Value indexes as the independent variables. Return-based style analysis suggests here that the style of the Fidelity Select Technology Fund fluctuated considerably between 1988 and 1998. For example, in 1995, the style analysis suggests that the fund was 15% large-cap value and 85% small-cap growth. But by 1998, style analysis suggests the fund was 50% large-cap growth and 50% small-cap growth.

It is quite doubtful that the fund's managers changed the investment policy for the fund by that much during a three-year period.

#### RETURN-BASED STYLE ANALYSIS AND MUTUAL FUND AGGREGATES

To better evaluate the stability of return-based style analysis, we analyze mutual fund aggregates instead of individual funds. We want to try to eliminate any indi-

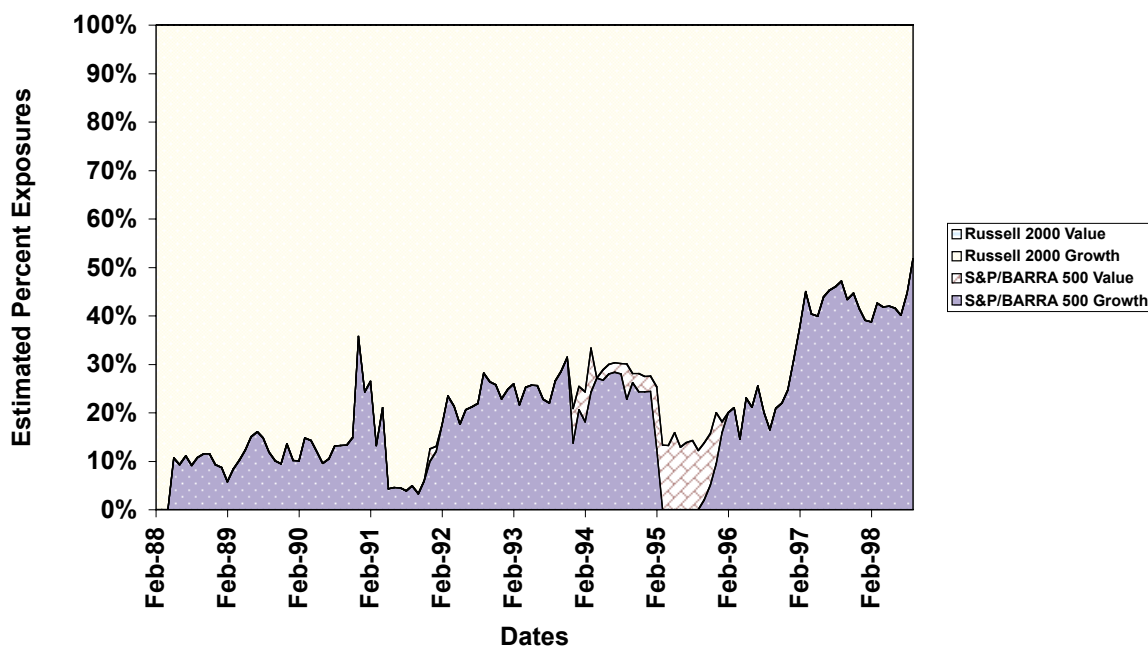
vidual mutual fund-specific properties. Our reasoning is simple. Individual mutual fund managers may differ in how they define and implement style in their portfolios. As a group, however, they should exhibit more consistent properties of the particular style category that they claim to espouse. The managers whose investment objective is growth-oriented should, as a group, possess relatively consistent results from return-based style analysis. If the entire group has volatile results, then the analysis by individual manager will be more problematical.<sup>7</sup>

Exhibits 2 and 3 illustrate this phenomenon. By analyzing exposures at the aggregate level, we may be able to determine if specific investment styles lend themselves to stable results from return-based style analysis.

The aggregates we use are the Morningstar Equity and Fixed Income aggregates from January 1985 through September 1998. The aggregates are described in Exhibit 5. The methodology followed is the same as that followed in producing Exhibits 2 and 3, and the independent variables are the same as those used in producing Exhibit 2. Exhibit 6 presents the average R-square and the standard deviation of the R-square for most of the aggregates over this period.<sup>8</sup>

The results in Exhibit 6 in conjunction with the results in Exhibits 7 and 8 are illuminating. A possible

**EXHIBIT 4**  
**THREE-YEAR ROLLING STYLE FOR FIDELITY SELECT TECHNOLOGY FUND (U.S. EQUITY)**



**EXHIBIT 5**  
**MORNINGSTAR AGGREGATE DESCRIPTIONS**

Aggregate Name	Description
Small Company	Seeks capital appreciation by investing primarily in stocks of small companies, as determined by market capitalization.
Growth	Seeks capital appreciation by investing primarily in equity securities of companies with earnings that are expected to grow at an above-average rate. Current income, if considered at all, is a secondary objective.
Growth and Income	Seeks growth of capital and current income as near-equal objectives, primarily through investment in equity securities with above-average yields and some potential for appreciation. This category includes the S&P 500 index funds.
Balanced	Seeks both income and capital appreciation by investing in a generally fixed combination of both stocks and bonds. In general, these funds will hold a minimum of 25% in stocks and 25% in bonds at any time.
Convertible Bond	Invests primarily in bonds and preferred stocks that can be converted into common stocks.
Corporate Bond Quality	Seeks income by investing in fixed-income securities, primarily corporate bonds of various quality ratings.
Aggressive Growth	Seeks rapid growth of capital, often through investment in smaller companies and with investment techniques involving greater-than-average risk, such as frequent trading, leveraging, and short-selling.
Pacific Stock	Invests primarily in issuers located in countries in the Pacific Basin, including Japan, Hong Kong, Malaysia, Singapore, and Australia.
Asset Allocation	Seeks both income and capital appreciation by determining the optimal percentage of assets to place in stocks, bonds, and cash. A top priority of managers of these funds is determining the correct allocation of assets to these sectors, a decision often based on an analysis of business cycle trends. Sometimes, separate managers will handle each class of security, and an allocator will oversee the process of determining the percentage of assets each asset class receives.
Diversified EM Stock	Seeks capital appreciation by investing primarily in equity securities issued in emerging markets worldwide. These funds generally do not concentrate their investments in any one region.
Equity-Income	Seeks current income by investing at least 65% of its assets in equity securities with above-average yields.
Europe Stock	Generally invests at least 65% of assets in equity securities of European issuers.
Foreign Stock	Invests primarily in equity securities of issuers located outside the United States.
Multiasset Global	Seeks total returns by investing in varying combinations of equities, fixed-income securities, and other asset classes. These funds may invest a significant portion of assets in securities of foreign issuers.
Specialty Miscellaneous	Seeks capital appreciation by concentrating its investments in a single industry or sector other than one of the following: Communication, Financial, Health, Natural Resources, Precious Metals, Real Estate, Technology, Utility.
Specialty Financial	Seeks capital appreciation by investing primarily in equity securities of financial services companies, including banks, brokerage firms, and insurance companies.
Specialty Health	Seeks capital appreciation by investing primarily in equity securities of healthcare companies, including drug manufacturers, hospitals, and biotechnology firms.
Specialty Natural Resources	Seeks capital appreciation by investing primarily in equity securities of companies involved in the exploration, distribution, or processing of natural resources.
Specialty Technology	Seeks capital appreciation by investing primarily in equity securities of companies engaged in the development, distribution, or servicing of technology-related equipment or processes.
Specialty Utility	Seeks capital appreciation by investing primarily in equity securities of public utilities.
Specialty Communication	Seeks capital appreciation by investing primarily in equity securities of companies engaged in the development, manufacture, or sale of communications products or services.



**EXHIBIT 5  
CONTINUED**

Aggregate Name	Description
World Stock	Invests primarily in equity securities of issuers located throughout the world, maintaining a percentage of assets (normally 25% to 50%) in the United States.
Corporate Bond — General	Seeks income by investing in fixed-income securities, primarily corporate bonds of various quality ratings.
Government — Adjustable-Rate Mortgage	Invests at least 65% of its assets in mortgage or mortgage-related securities with adjustable coupons. These securities are usually backed by the U.S. government.
Government Bond — General	Invests in a blend of mortgage-backed securities, Treasuries, and government agencies.
Government Bond — Mortgage	Seeks income by generally investing at least 65% of its assets in securities backed by mortgages, such as securities issued by the Government National Mortgage Association (GNMA), the Federal National Mortgage Association (FNMA), and the Federal Home Loan Mortgage Corporation (FHLMC).
Government Bond — Treasury	Seeks income by generally investing at least 80% of its assets in U.S. Treasury securities.

Source: Morningstar, 1999.

**EXHIBIT 6  
R-SQUARE INFORMATION BY FUND TYPE**

Aggregate Name	Average R-Square	Std. Dev. of R-Square
Small Company	97.982	1.247
Growth	98.949	0.397
Growth and Income	99.642	0.108
Balanced	99.477	0.106
Convertible Bond	95.093	2.025
Corporate Bond Quality	99.420	0.250
Aggressive Growth	95.062	3.061
Pacific Stock	75.436	8.208
Asset Allocation	98.624	0.712
Diversified Emg. Markets Stock	69.963	22.641
Equity-Income	98.516	0.727
Europe Stock	91.605	4.140
Foreign Stock	92.697	3.877
Multiasset Global	83.743	6.273
Specialty Miscellaneous	96.049	1.903
Specialty Financial	82.930	8.054
Specialty Health	79.211	13.022
Specialty Natural Resources	66.360	10.407
Specialty Technology	80.637	9.367
Specialty Utility	80.296	9.840
Specialty Communication	86.241	3.838
World Stock	95.462	2.606
Corporate Bond General	98.508	0.708
Govt. Adjustable-Rate Mortgage	84.788	8.353
Government Bond General	99.274	0.439
Government Bond Mortgage	98.511	1.225
Government Bond Treasury	97.935	2.476

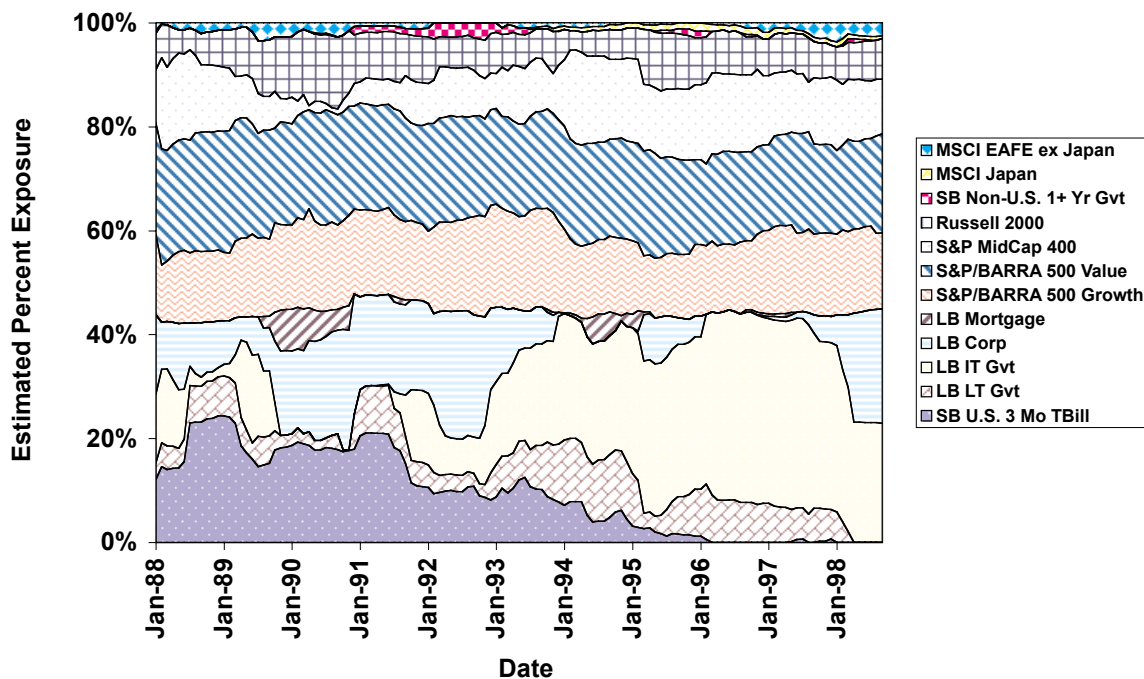
interpretation of the results is that a stable R-square means that the return-based style analysis has consistent results. Exhibits 7 and 8 show the detailed return-based style analysis for balanced funds and asset allocation funds. Each of these has a very high and stable R-square over the period analyzed, yet the exposures do change through time. Such change makes interpretation of the analysis difficult.

This is not surprising for funds of this nature because, by definition, their exposures to different asset classes are *supposed* to change through time. Our results merely indicate that return-based style analysis for funds in these and similar categories must be used with extreme caution.

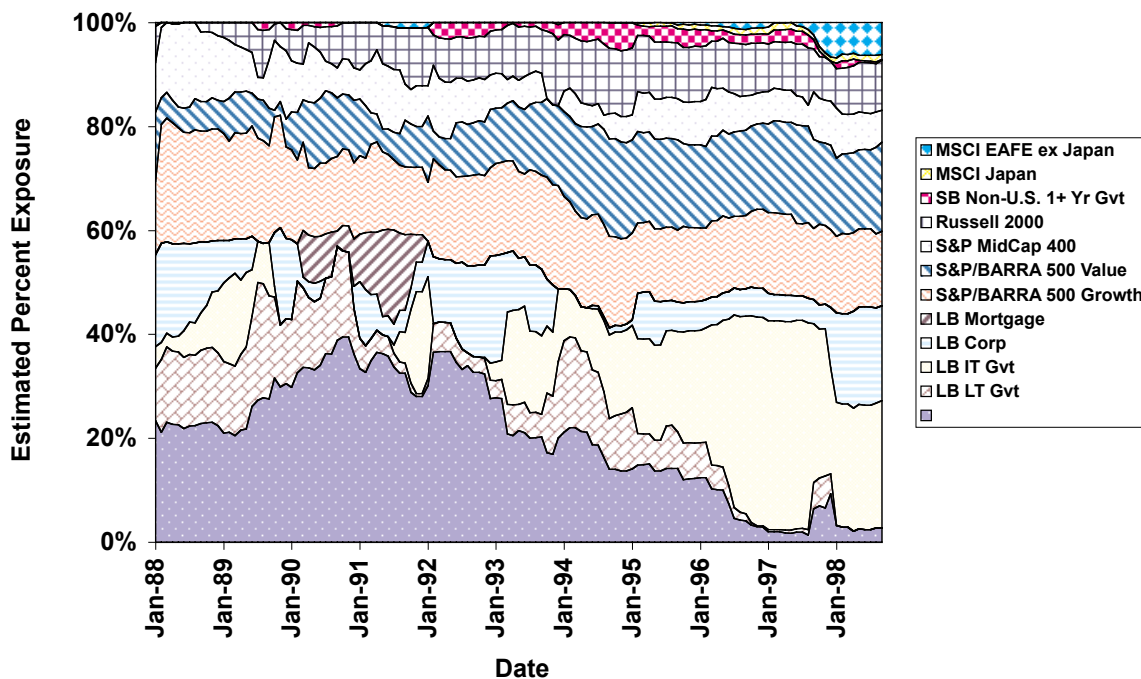
While these funds undoubtedly have a dynamic exposure profile, they are stable compared to funds that have a relatively large standard deviation of R-square. Exhibits 9 and 10 present the return-based style analysis for multiasset global funds and specialty technology. These results clearly illustrate that return-based style analysis is far too non-stationary to have any useful purpose when used in isolation.

Exhibits 11 through 13 present the results for the traditional mutual fund categories: aggressive growth, growth, and growth and income. Both growth and aggressive growth have dynamic exposures, but the growth and income category is relatively stable through time. This is not surprising, since the S&P 500 index

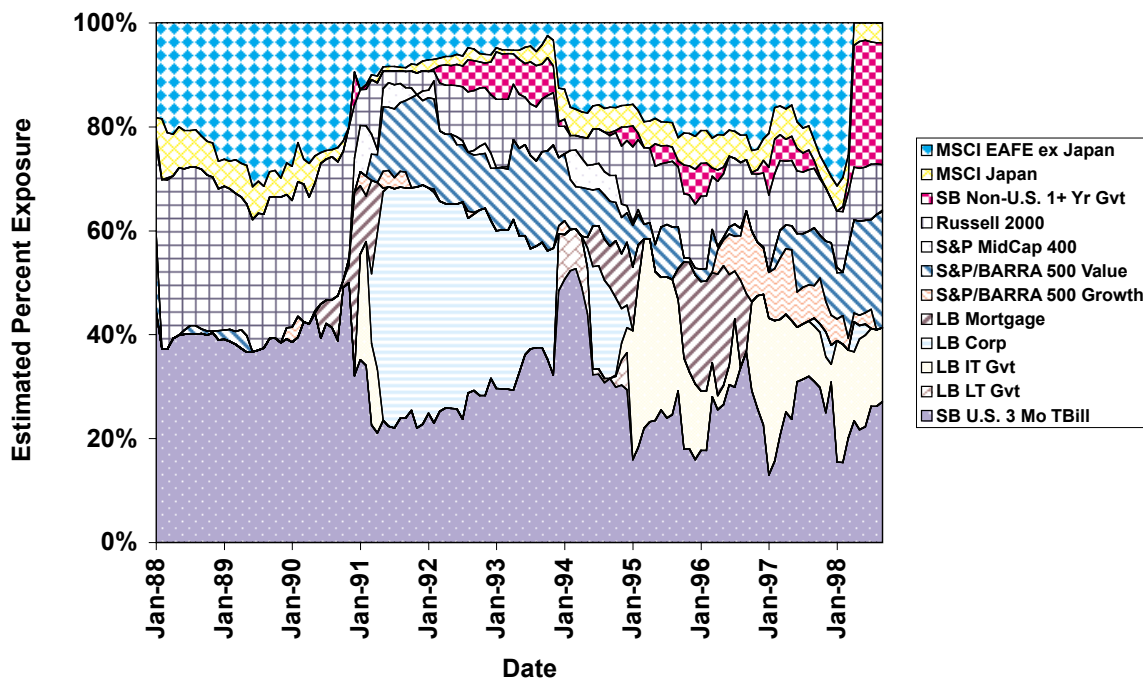
**EXHIBIT 7  
THREE-YEAR ROLLING STYLE FOR BALANCED FUNDS**



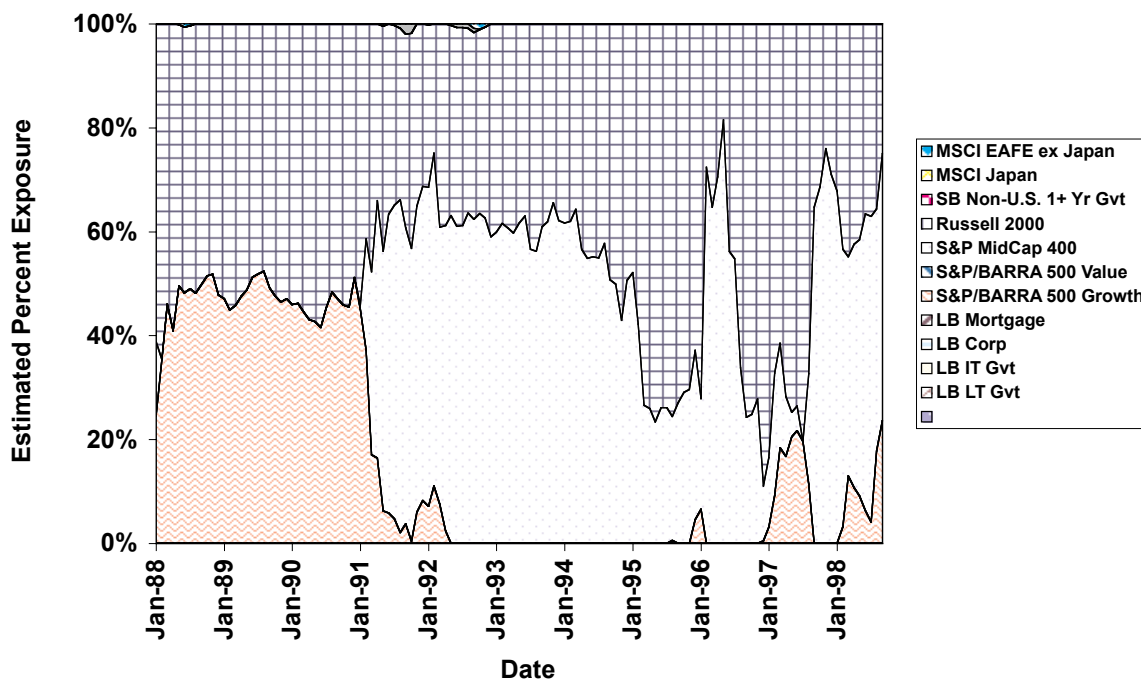
**EXHIBIT 8  
THREE-YEAR ROLLING STYLE FOR ASSET ALLOCATION FUNDS**



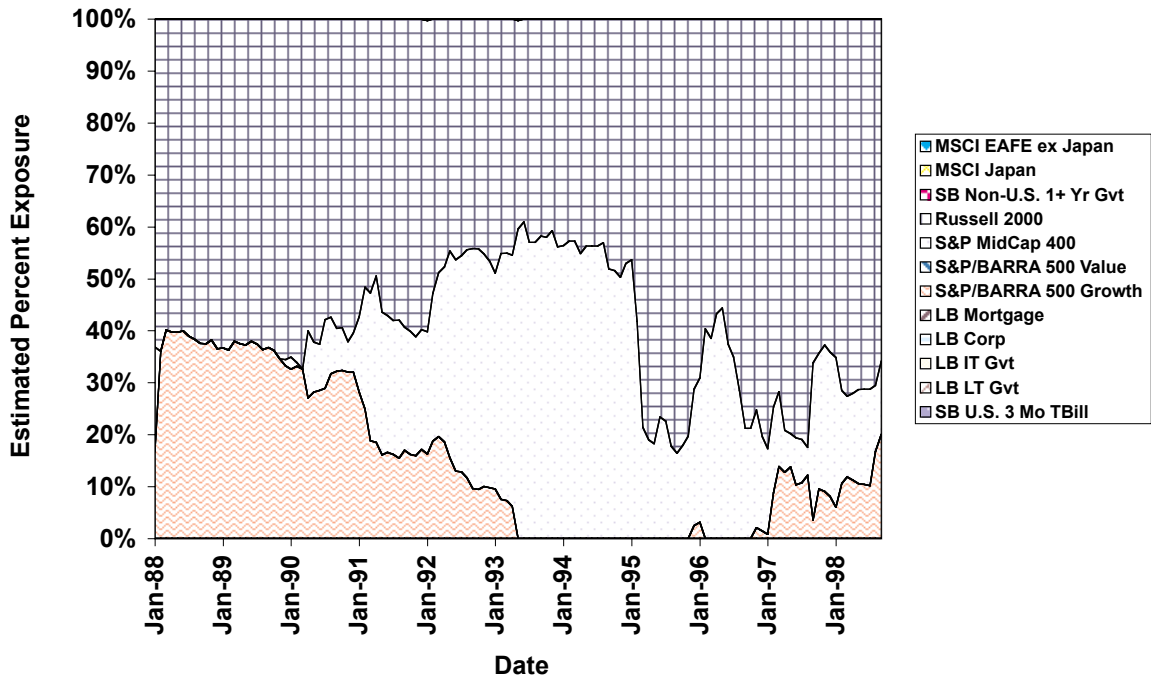
**EXHIBIT 9**  
**THREE-YEAR ROLLING STYLE FOR MULTIASSET GLOBAL FUNDS**



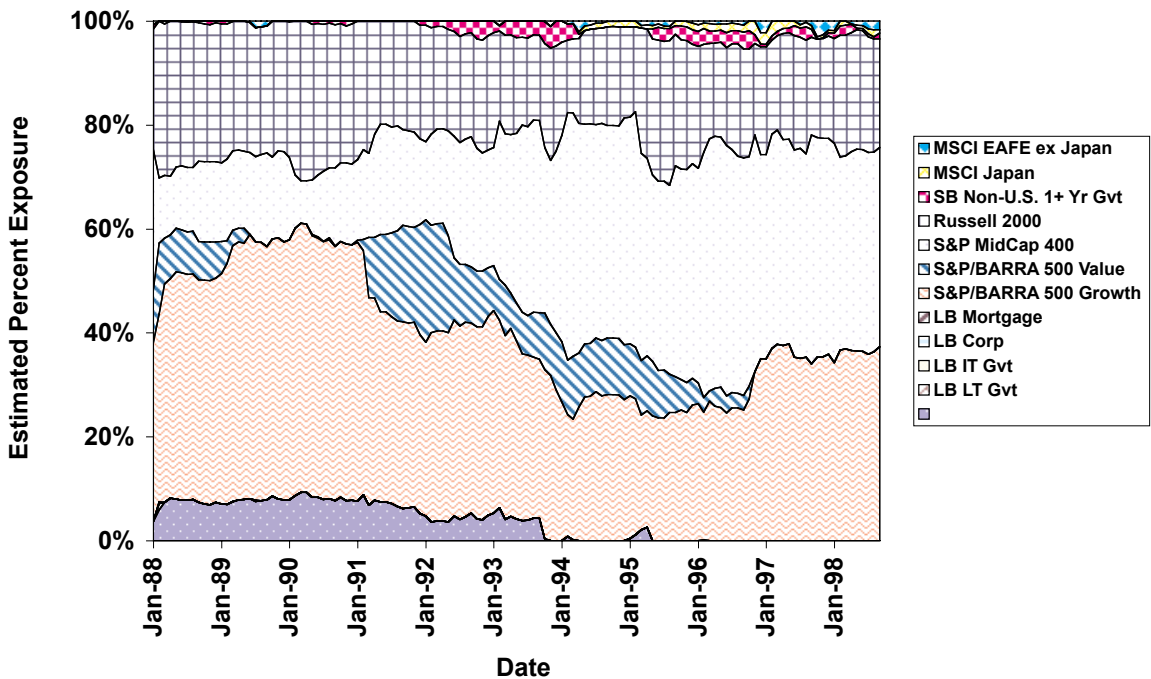
**EXHIBIT 10**  
**THREE-YEAR ROLLING STYLE FOR SPECIALTY TECHNOLOGY FUNDS**



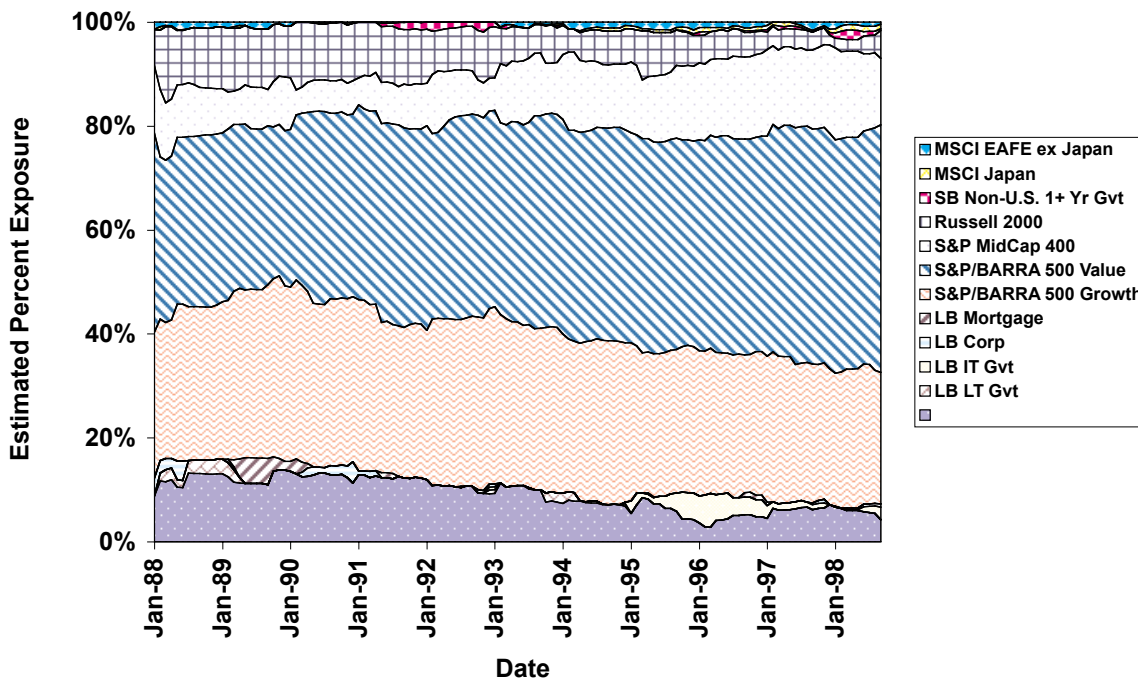
**EXHIBIT 11**  
**THREE-YEAR ROLLING STYLE FOR AGGRESSIVE GROWTH FUNDS**



**EXHIBIT 12**  
**THREE-YEAR ROLLING STYLE FOR GROWTH FUNDS**



**EXHIBIT 13**  
**THREE-YEAR ROLLING STYLE FOR GROWTH AND INCOME FUNDS**



funds are included in this category. Index funds will possess stable characteristics if the independent variables include the index or components of the index. Recall that when the DV returns are not properly represented by the IV returns, return-based style analysis will have unstable, even questionable results. With index funds, this problem is eliminated, resulting in stable and useful return-based style analysis.

Exhibits 14 and 15 show the results for two bond categories: corporate bonds (general) and government bonds (Treasury). Not surprisingly, these are fairly stable through time. We suggest that this can be attributed to well-defined styles. With well-defined styles, proper independent variables can be chosen to represent the investment objective of the fund being analyzed.

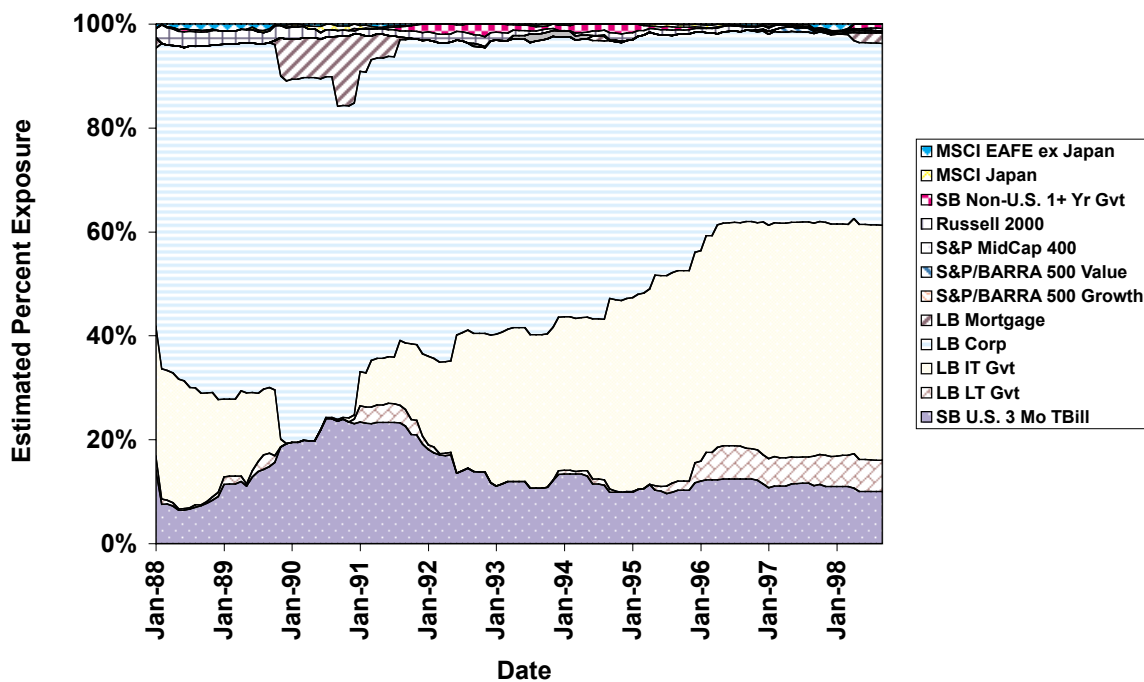
We have shown that both individual mutual funds and mutual fund aggregates produce inconsistent results from return-based style analysis, and that the choice of independent variables influences the exposures greatly. The mutual fund aggregates are more stable but still erratic. We believe that these results are largely due to the difficulty of defining a style and finding compatible IVs to capture the investment strategy properly.

**USING RETURN-BASED STYLE ANALYSIS PROPERLY**

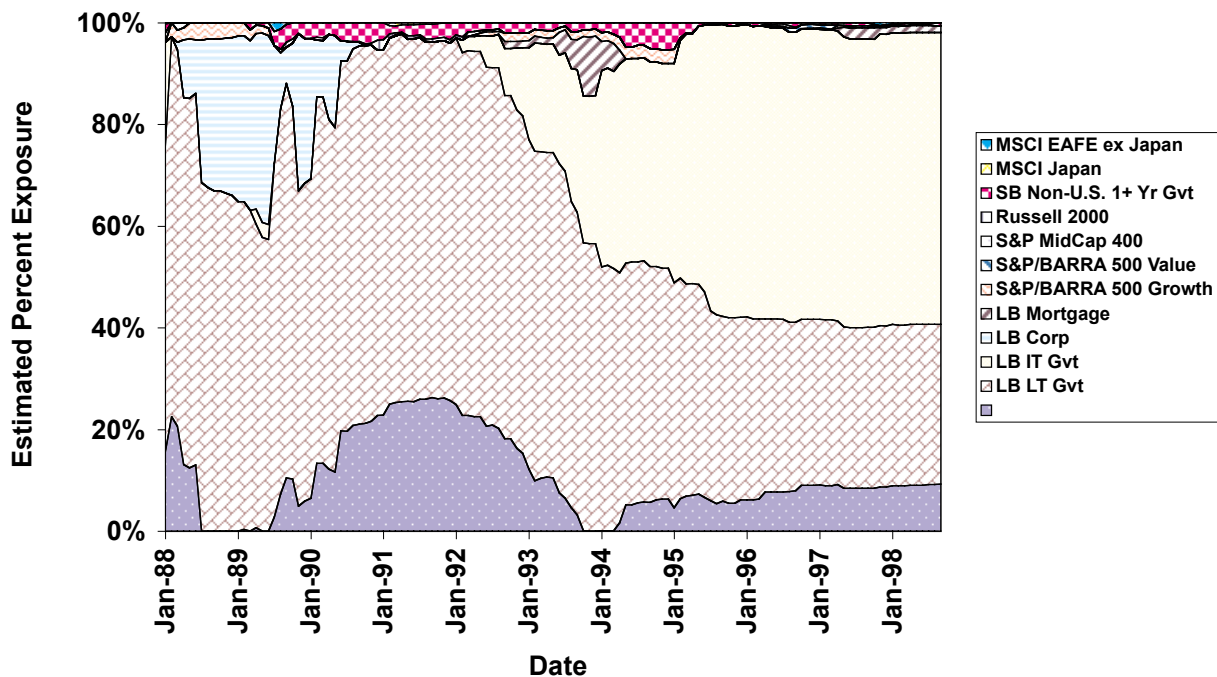
For return-based style analysis to be useful, well-defined, and well-understood variables must appear on both sides of the factor equation. To illustrate this point, we perform an analysis similar to that described above on three Vanguard Funds: Vanguard Index 500, Vanguard Index Growth, and Vanguard Index Value. All three of these are index funds (S&P 500, S&P/BARRA growth index, and S&P/BARRA value index). Since each of these funds' investment objectives is easily captured with the proper independent variables, we would expect the return-based style analysis to produce stable results through time.

Exhibits 16 through 18 present the results. All the R-squares are above 99.5% with standard deviations of less than 0.2%. More important, the exposures are extremely stable. Because these results truly represent the portfolio manager's objective in each case, they can be used advantageously by investment decision-makers to evaluate performance in a tactical asset allocation framework when assets are indexed.

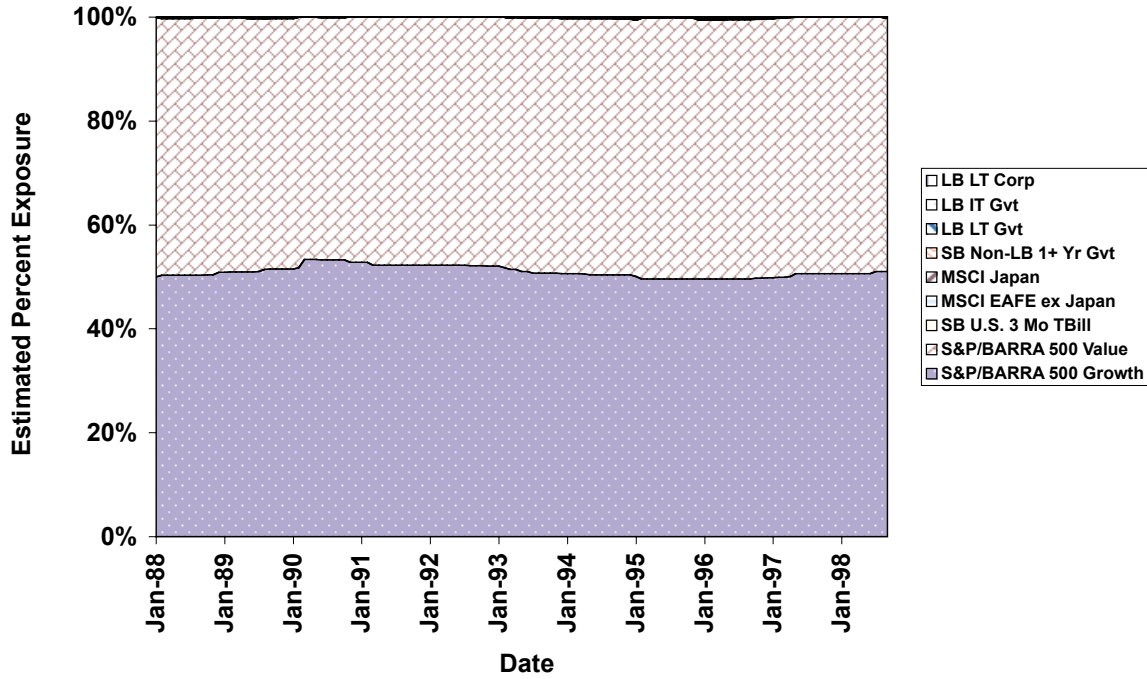
**EXHIBIT 14**  
**THREE-YEAR ROLLING STYLE FOR CORPORATE BOND FUNDS**



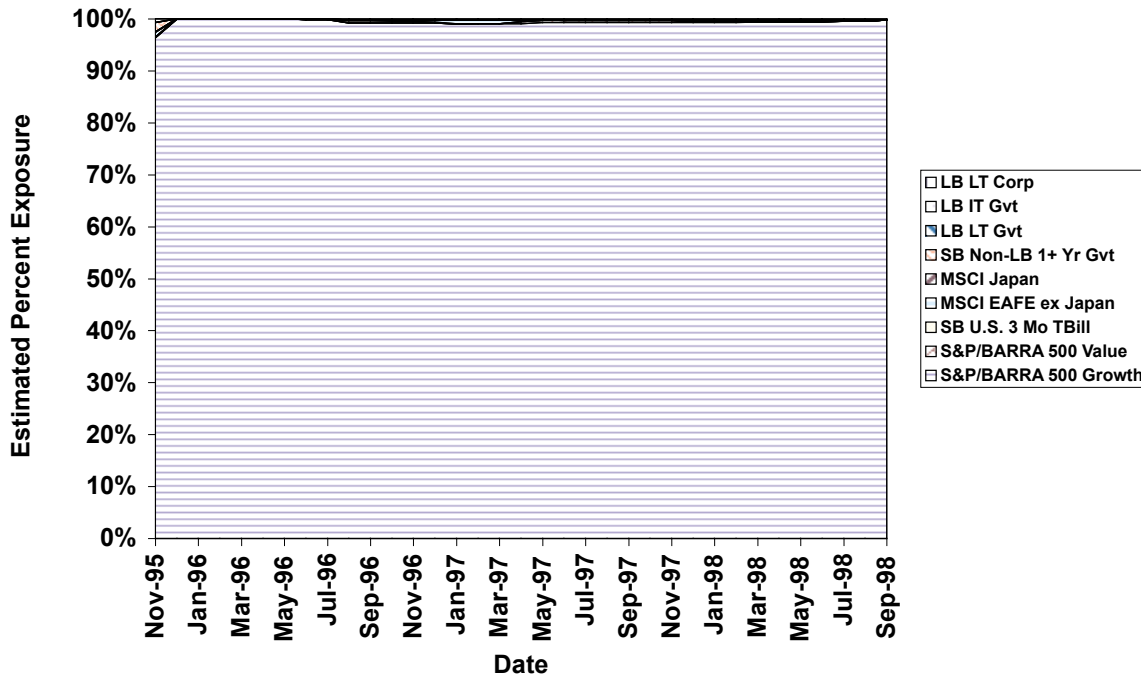
**EXHIBIT 15**  
**THREE-YEAR ROLLING STYLE FOR GOVERNMENT BOND TREASURY FUNDS**



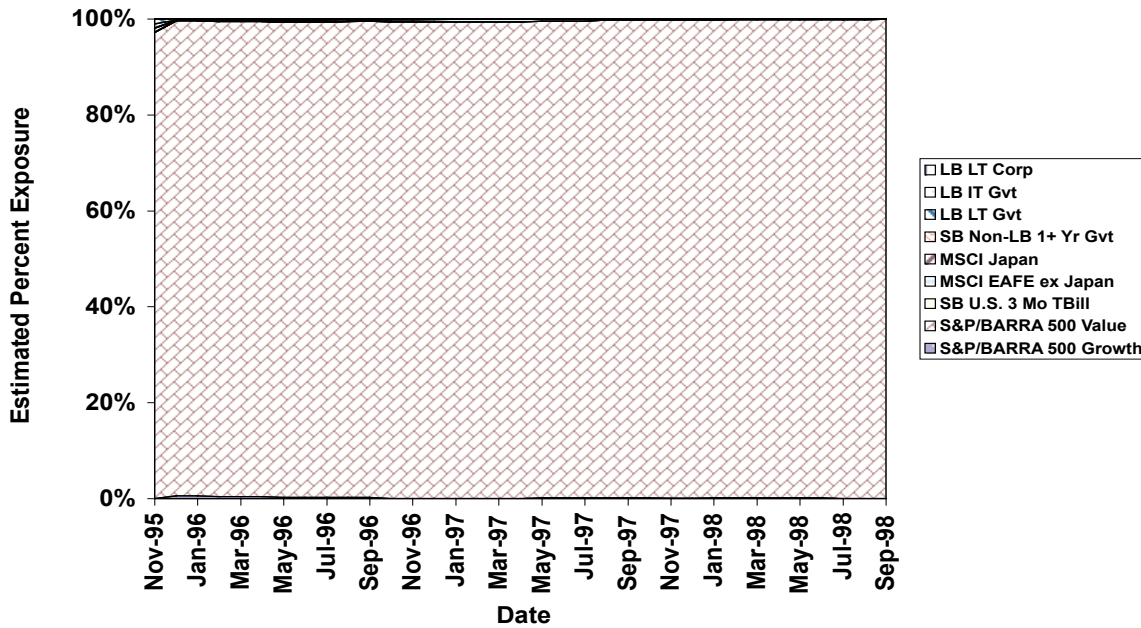
**EXHIBIT 16**  
**THREE-YEAR ROLLING STYLE FOR VANGUARD INDEX 500 FUND**



**EXHIBIT 17**  
**THREE-YEAR ROLLING STYLE FOR VANGUARD INDEX GROWTH FUND**



**EXHIBIT 18**  
**THREE-YEAR ROLLING STYLE FOR VANGUARD INDEX VALUE FUND**



**WHAT DOES ALL THIS MEAN?**

When style is difficult to define, we have shown that the results of return-based style analysis should not be used in isolation. Return-based style analysis should not be used to make asset allocation decisions when the investment objectives of the individual managers are not precisely defined. The results in loosely defined or compound-defined situations are simply too prone to change through time and too sensitive to the choice of IVs.

Return-based style analysis can and should be used to analyze asset allocation decisions if the assets are indexed to well-prescribed indexes (such as the S&P/BARRA equity indexes). In these cases, the factor equation is well described on both sides of the equation, and the return-based style analysis will be both stable and consistent through time and can be used in decision-making and in performance evaluation.

If return-based style analysis is not appropriate to benchmark non-indexed portfolios, what methods are appropriate? Bailey and Tierney [1993] and Bailey [1992b] suggest an alternative approach. They suggest that managers should create their own benchmarks, based on the universe of eligible securities fitting the managers' investment style. Clients should use benchmark quality tests

to ensure that the benchmark can correctly attribute returns to active management in the portfolio (Bailey 1992b)).

Certainly, using custom benchmarks is more expensive than using return-based style analysis to create a benchmark. Yet the style instability we have found in return-based style analysis suggests that using custom manager-constructed benchmarks is the best alternative for evaluating portfolios or mutual funds that use a strategy other than indexing.<sup>9</sup>

**PUTTING IT ALL TOGETHER**

Return-based style analysis must be used with care by both the investment decision-maker (such as a plan sponsor) and by portfolio managers. We demonstrate that the results of return-based style analysis can be so dynamic that they are of little analytical use. If portfolio managers know they will be judged by such an analysis, they may change their investment philosophy to obtain the results desired by the decision-maker. Conversely, the decision-maker who uses return-based style analysis improperly may select a portfolio manager for the wrong reasons. Both scenarios are suboptimal, and should be avoided by confining return-based style analysis to its appropriate uses.

Return-based style analysis does have a place in



the investment decision process. When the investment philosophy is well defined, stable over time, and represented by an index, return-based style analysis results are very useful. This suggests that return-based style analysis can be effectively employed when determining the appropriate asset mix or judging a tactical asset allocation strategy when the asset classes are uniquely defined and are indexed. The index can be a portfolio-specific benchmark as prescribed in Bailey [1992a].

## CONCLUSION

Return-based style analysis is a useful tool only when the investment philosophy of the portfolio manager is well understood *and* there are a set of asset classes that properly capture this philosophy. Without this framework, the results of the analysis are far too dynamic to have any useful application in the investment decision-making process.

Perhaps the best application of return-based style analysis is in examination of asset allocation strategies where the assets are indexed. In this environment, whether value is added or lost through altering asset allocation away from the neutral portfolio can be easily determined.

Finally, our findings strongly support the creation of portfolio-specific benchmarks. These benchmarks can be used for both performance measurement and return-based style analysis.

## ENDNOTES

<sup>1</sup>Trzcinka [1997] discusses many of the important implications of style management from the perspective of the plan sponsor.

<sup>2</sup>Both Russell and BARRA, for example, use price-to-book ratio to separate the universe of securities into growth or value stocks.

<sup>3</sup>Even if this were the only use, it would not be as limiting as it appears, since many studies have documented the importance of asset allocation in explaining portfolio returns (see, for example, Brinson, Hood, and Beebower [1986]).

<sup>4</sup>We believe a three-year rolling period to be representative of the way style analysis is commonly implemented. The volatility of results is directly related to the length of the rolling period. As the period lengthens, the results become more consistent. The longer the period, however, the less sensitive the results are to fundamental changes in investment policy. Results for a five-year rolling period are not materially different in most cases. Sharpe [1992] does not mention the length of the rolling period used.

<sup>5</sup>The average explanatory power using the inputs for Exhibits 2 and 3 is 83.73% and 73.89%, respectively. Given the correlation between the Russell and the BGI Growth indexes, this is a very peculiar result also.

<sup>6</sup>Since many of the return series in this style analysis are highly correlated, there is severe multicollinearity in the constrained

regressions used for most return-based style analyses. Consequently, the coefficients in these regressions (the style weights) can be quite unstable, as Exhibits 2 and 3 illustrate.

<sup>7</sup>Results from individual funds (not shown) are far more erratic than the aggregates. Consequently, we are confident that the aggregate argument is valid.

<sup>8</sup>The results for all the aggregates are available from the authors upon request.

<sup>9</sup>Bailey and Tierney [1993] also show how to use the right performance measures so that managers will not have an incentive to create a benchmark portfolio that they can easily beat.

## REFERENCES

Bailey, J. "Are Manager Universes Acceptable Performance Benchmarks?" *Journal of Portfolio Management*, Spring 1992, pp. 9-13.

———. "Evaluating Benchmark Quality." *Financial Analysts Journal*, May/June 1992b, pp. 33-39.

Bailey, J., and D. Tierney. "Gaming Manager Benchmarks?" *Journal of Portfolio Management*, Summer 1993, pp. 37-40.

Bogle, J. "The Implications of Style Analysis for Mutual Fund Performance Evaluation." *Journal of Portfolio Management*, Summer 1998, pp. 34-42.

Brinson, G., L. Hood, and G. Beebower. "Determinants of Portfolio Performance." *Financial Analysts Journal*, July/August 1986.

Brown, M.R., and C.E. Mott. "Understanding the Differences and Similarities of Equity Style Indexes." In T.D. Coggin, F. Fabozzi, and R. Arnott, eds., *The Handbook of Equity Style Management*, 2nd ed. Philadelphia: Fabozzi and Associates Publishing, 1997.

Christopherson, J. "Equity Style Classifications." *Journal of Portfolio Management*, Spring 1995, pp. 32-43.

DiBartolomeo, R., and E. Witkowski. "Mutual Fund Misclassification: Evidence Based on Style Analysis." *Financial Analysts Journal*, 53 (September/October 1997), pp. 32-43.

Michaud, R.O. "Is Value Multidimensional? Implications for Style Management and Global Stock Selection." *Journal of Investing*, 7 (Spring 1998), pp. 61-65.

Sharpe, W. "Asset Allocation: Management Style and Performance Measurement." *Journal of Portfolio Management*, Winter 1992, pp. 7-19.

———. "Determining a Fund's Effective Asset Mix." *Investment Management Review*, December 1988, pp. 59-69.

Tierney, D., and K. Winston. "Using Generic Benchmarks to Present Manager Styles." *Journal of Portfolio Management*, Summer 1991, pp. 33-36.

Trzcinka, C. "Is Equity Style Management Worth the Effort? Some Critical Issues for Plan Sponsors." In T.D. Coggin, F. Fabozzi, and R. Arnott, eds., *The Handbook of Equity Style Management*, 2nd ed. Philadelphia: Fabozzi and Associates Publishing, 1997.