by Jeffery V. Bailey and Robert D. Arnott

Cluster Analysis and Manager Selection

With the displacement of the single, balanced pension fund manager by multiple specialty managers, control of total portfolio diversification has passed largely into the hands of the plan sponsor. The sponsor's allocation of plan assets to managers having different investment "styles" can have significant impact on portfolio risks and returns. For example, the ability to rotate among different managers in order to take advantage of the market's cyclical tendency to reward first one investment style, then another, can significantly improve total portfolio performance; conversely, employing several managers whose styles are subject to similar extramarket risks can amplify the plan's risk of investment losses.

To differentiate between manager styles, sponsors have historically relied on subjective judgment and, more recently, complicated quantitative techniques such as fundamental factor models. A simple, yet objective, method for categorizing managers may be found in cluster analysis—a technique that has proved effective in grouping common stocks according to shared exposures to different types of extramarket risk. Tests indicate that cluster analysis, using correlation coefficients between performance histories to group managers, can accurately identify and differentiate between managers having different investment styles.

THE STRUCTURE OF institutional pension management has evolved dramatically over the last 20 years. One of the most interesting changes has been the widespread displacement of the single, balanced manager by a number of "specialty" managers.[1] Specialists tend to focus their investment efforts on one broad asset class (e.g., stocks or bonds), rather than on a diversified universe of securities. Their investment philosophies are often considerably more aggressive than those of balanced managers. And successful specialty managers have been able to demonstrate performance within their asset classes far superior to what balanced managers have produced within the same classes.

There are two broad rationales for a multi-manager approach. William Sharpe has characterized them in terms of the "diversification of judgment" and the "diversification of style."[2]

"Diversification of judgment" is a straightforward concept. By employing multiple managers, even within a single asset class, a plan sponsor assumes that the managers in the aggregate will produce superior returns.[3] By diversifying across multiple managers, the fund will limit its exposure to incorrect market timing or security selection decisions on the part of any one manager.

Diversification of style is somewhat more complex. The replacement of a balanced manager by specialty managers has left the control of total portfolio diversification largely in the hands of the plan sponsor. Unless the sponsor is cognizant of the individual investment styles of its managers, the plan's total portfolio may take on unintended forms of extramarket risk, which could produce unexpected performance results, for better or worse.

If a plan sponsor is to differentiate between

1. Footnotes appear at end of article.

Jeffery Bailey is Assistant Executive Director of the Minnesota State Board of Investment. Robert Arnott is President and Chief Investment Officer of TSA Capital Management, Los Angeles.

money managers, then it must develop measures of the relevant risk characteristics, hence styles, of the managers' portfolios. Several different approaches exist. The judgmental approach, widely employed by plan sponsors and consultants, is inexpensive and easy to apply, but its conclusions are open to conflicting interpretations. More sophisticated quantitative techniques, such as fundamental factor models and normal portfolios, are expensive and time-consuming and may prove impractical, particularly in a manager search process, when a large number of managers must be reviewed in a very short time.

This article discusses a simple yet effective form of quantitative analysis that permits a plan sponsor to categorize a large number of candidate managers quickly and inexpensively, using readily available performance data. The approach is based on cluster analysis. Used in prior studies to identify significant, extramarket, systematic sources of risk in common stocks, cluster analysis lends itself just as effectively to the identification of extramarket similarities among groups of money managers.[4]

Investment Style and Performance

A manager's investment style may be characterized by the set of fundamental investment principles the manager uses, on a consistent basis, to construct portfolios. These principles apply to all facets of the investment decision-making process, from asset class choice to individual security selection. Among common stock specialty managers, investment styles range from the highly diversified, index-like approach of traditional bank trust departments to such extremely nondiversified strategies as investing in a limited number of small-capitalization, high-growth stocks.

Because a manager's decision to pursue a particular style exposes his portfolio to certain types and levels of extramarket risk, the plan sponsor cannot ignore the impact of a manager's style on the total risk composition of a multiple manager portfolio. Even if the sponsor were confident that certain managers were capable of long-term superior performance, no manager can exhibit superior returns in every quarter, or even in every year. Capital markets move in cycles: Different asset classes and sectors within those asset classes will experience cycles of strong and weak performance. Similarly, investment styles will go through periods in which one or another style is rewarded or penalized by the market; growth managers may perform well one year, value managers the next.[5]

Consider a pension plan invested primarily in small-capitalization growth stocks. Over certain periods—for example, the late 1970s—this plan's performance would likely have been exceptional. At other times, returns would have been abysmal. The plan would have experienced both extremes without changing either managers or styles.

A given manager's relative performance may be expected to fluctuate over the course of a market cycle, regardless of the manager's true ability. In any particular period, a manager may perform well relative to the market simply because his investment style is "in favor"; as the adage goes, "Markets make managers." By using a consistent framework of manager styles to select managers, the plan sponsor can more effectively protect against the possibility that the total portfolio will be exposed to unintended forms of extramarket risk arising from a particular manager's investment style.

Rotating Among Styles

Because of the cyclical nature of the capital markets, the diversification of a pension plan's portfolio across investment management styles can have a significant impact on the total portfolio's performance. As the market moves through its irregular but persistent cycle, particular investment styles move in or out of favor. This process is dynamic and largely out of the control of an investment manager following a specific style. Given this cyclical environment, a plan sponsor using a multiple manager approach will make explicit *or implicit* decisions regarding the plan's exposure to particular investment styles. This exposure could remain static over time, or the sponsor may shift exposure through a changing selection of managers.

The potential impact of diversification across management styles can be observed by examining the performance of groups of equity managers. Table I shows the equal-weighted average performances, over selected periods, of a sample of growth and value managers. The poor performance of the growth style relative to the value style is striking. In the 10-year period when the S&P 500 produced an annual return of 14.8 per cent, the growth managers returned 14.6 per cent, despite the high beta of most

Table I Compounded Cumulative Returns Over Selected Periods

Period	*S&P 500*	*Growth Managers*	*Value Managers*	*Best Performing Style*	*Worst Performing Style*
1975 I–1976 I	+57.6%	41.0%	53.7%	53.7%	41.0%
1976 II–1978 I	−4.8	−1.9	12.6	12.6	−1.9
1978 II–1980 IV	75.9	99.9	67.4	99.9	67.4
1981 I–1982 II	−12.4	−11.4	1.8	1.8	−11.4
1982 III–1983 II	61.1	68.4	62.4	68.4	62.4
1983 III–1984 IV	6.6	−5.3	9.3	9.3	−5.3
10-Yr. Annual Return	14.8%	14.6%	18.0%	20.5%	12.2%
10-Yr. Cumulative Gain	+298%	+291%	+423%	+545%	+216%

growth managers. By contrast, the value style performed very well (18.0 per cent per annum), particularly in light of the fact that most value managers have low portfolio betas.

Despite the growth managers' generally poor aggregate performance over the 10-year period, there were times when the growth style outperformed the value style. From April 1978 through year-end 1980, the growth managers outperformed the value managers by over 30 percentage points!

If a plan sponsor had had the foresight to switch management styles completely from value to growth and back at the appropriate times, the effects on portfolio performance would have been dramatic. Rotation with perfect foresight could have added 247 percentage points relative to the S&P 500. The risk of untimely style shifts is shown by the 82 per cent shortfall (relative to the S&P 500) of the "worst style" scenario.

This hypothetical example does not take into account such real-world obstacles as inadequate forecasting ability, transaction costs or management fees. Nevertheless, it illustrates the importance of diversifying a total portfolio across different investment styles. A pension plan with a sizable investment in the wrong style at the wrong time will experience disappointing results. Conversely, correctly projecting the most profitable style can add considerably to total portfolio performance. A pension sponsor should be fully aware of the style orientation of its current and prospective managers. A sponsor that chooses to allow a single style to dominate pension assets should contemplate the risks of such a stance.

Cluster Analysis

Several techniques are currently employed to classify managers according to investment style. The most commonly used method is a simple judgmental approach. Based on discussions with a manager, and on inspection of such portfolio financial data as dividend yield and price-to-earnings ratio, a plan sponsor or consultant will subjectively assign the manager to a style category.

Considerably more sophisticated techniques are rapidly gaining popularity but remain less widely used. For example, fundamental-factor models break down a manager's portfolio risk into systematic, common-factor and specific components. Viewed historically, risk positions consistently assumed by a manager, particularly prominent common-factor risk positions, can be used to evaluate the manager's style with some precision.

Normal portfolios, which may also use prominent portfolio risk characteristics as a foundation, are another form of manager-style classification. A manager's normal portfolio represents the universe of securities and weighting rules the manager consistently uses to construct portfolios. The normal portfolio is that portfolio the manager would hold in the absence of investment judgment. Hence it is a passive reflection of the manager's style.

Each of these three methods of style identification presents advantages and disadvantages. The subjective approach is simple and inexpensive to apply. However, like any qualitative approach, it is not a rigorous technique and is open to conflicting interpretations by different observers.

The fundamental-factor model and normal portfolio approaches are disciplined and sophisticated quantitative methodologies, the forefront of manager style classification techniques. However, these approaches are very expensive and time consuming, requiring considerable historical portfolio data and elaborate computer algorithms. Particularly in the manager search process, where a plan sponsor may be reviewing a large number of managers in a very short

time period, these approaches may prove to be unwieldy.

Cluster analysis retains the simplicity and ease of application of the qualitative approach, yet incorporates quantitative rigor in its evaluation of the past performance patterns of managers. If particular managers consistently pursue investment strategies that expose them to similar extramarket risk, their performance results should be similar. If these patterns do not exist, the process of categorizing manager investment styles is a futile venture.

An important drawback in this application of cluster analysis is that it is based on the assumption that manager style does not change. This problem also affects other quantitative tools for manager evaluation. If an investment manager has significantly changed the investment process or style of investment during the period covered by the cluster analysis, or if the manager deliberately shifts investment style periodically, then cluster analysis is not a suitable tool.[6] Nonetheless, significant changes in investment style are not common in the money management community.

Data and Method

Cluster analysis identifies groups, or clusters, with similar characteristics, using the following procedure. Correlation coefficients between each pair of performance histories are calculated. The correlation matrix is searched for the greatest positive correlation coefficient between two managers. These managers' performance histories are then combined into a cluster, which is treated as a single performance history. The correlation matrix is recalculated, reduced in size by one. The greatest positive correlation coefficient is again found and a new cluster is created. The correlation matrix is again recalculated and reduced by one. This clustering process continues until the correlation matrix becomes a single number. However, examining the process before this final step usually reveals clusters of managers much more highly correlated within each cluster than across clusters.[7]

The data for our cluster analysis study was supplied by Evaluation Associates (EAI), a Westport, Connecticut consulting firm. EAI made quarterly total portfolio return data available on a wide variety of common stock managers, whose performance the firm monitors for its clients.[8] Only those managers for which data were available continuously over a 10-year period from 1975 through 1984 were included in the study.

In total, EAI supplied 10-year quarterly returns for 59 investment managers. The quarterly returns were risk-adjusted using the standard Capital Asset Pricing Model to remove systematic returns generated by the market factor. Correlation coefficients between the risk-adjusted returns were then calculated. These correlation coefficients provided the basis for the cluster analysis.

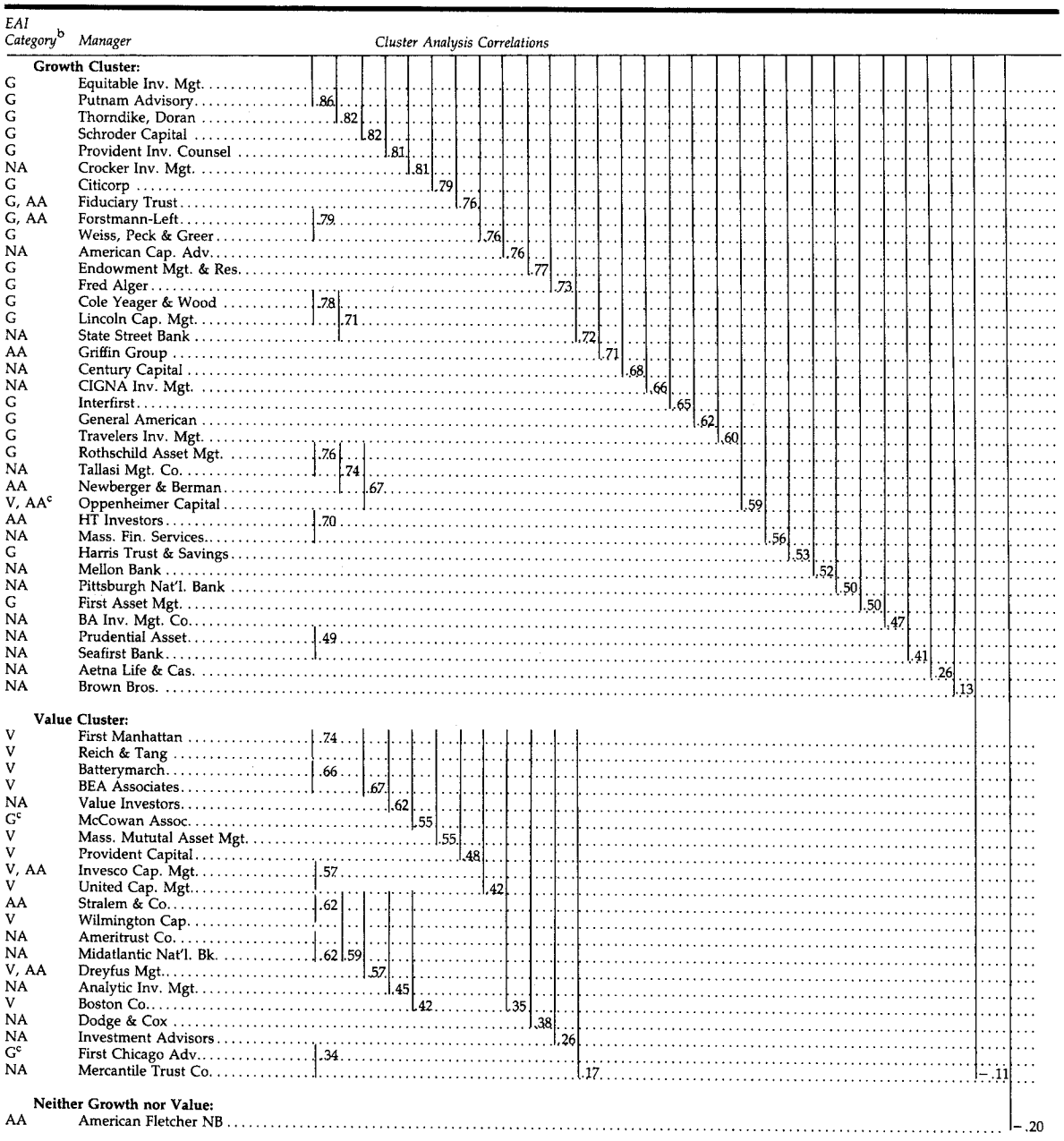
Results

Table II presents the cluster analysis test results. The managers used in the study are listed on the left side of the chart with the EAI style categorization noted by each name. The cluster chart is examined by moving from top to bottom. Each vertical line represents a step in the clustering procedure, and spans the managers grouped together on that particular step of the cluster analysis. At each pass, either a manager joins an existing cluster or forms a new one with another manager. The percentage correlation for each step of the cluster procedure is shown next to the line spanning the members of the cluster.

As Table II reveals, most managers fall into the categories of growth and value. It has become quite common in the institutional investment community to refer to "growth" and "value" investment styles. Growth managers generally search for companies whose earnings are expected to increase significantly, either on a cyclical or a secular basis. Growth managers believe that these strong earnings growth expectations are not fully reflected in the prices of the particular securities. The stocks in a growth manager's portfolio will usually exhibit above-average P/Es and below-average dividend yields. Value managers, by contrast, search for stocks that are selling at discounts to fair value based upon estimates of company asset values or near-term expected earnings. Value managers generally seek to hold out-of-favor issues with below-average P/Es or above-average dividend yields.

The analysis generally supports the categories selected judgmentally by EAI. It is encouraging to note that, of the 38 managers EAI felt could be categorized, there were just three instances in which the judgmental classification was not supported by cluster analysis. Oppenheimer Capital joins the growth manager cluster, with a

Table II Cluster Analysis[a]



a. Each vertical line spans the managers included in a cluster. The number to the right of the line shows the correlation between the managers or clusters that are merging to form the new cluster.
b. Categories are as follows:
G = growth manager
V = value manager
AA = asset allocator
NA = not categorized by EAI.
c. EAI category not supported by cluster analysis.

correlation of 0.59. McCowan Associates joins the value cluster, with a correlation of 0.55. These are strong correlations (given the calculation is based on extramarket returns), and call the accuracy of these manager classifications into question. The third potential misclassification is First Chicago, which joins the value cluster with an insignificant correlation of 0.17.

Table III shows that 12 managers not categorized by EAI can be categorized based on cluster

Table III Results for 59-Manager Cluster Analysis

A. Managers not categorized by EAI; categorized through cluster analysis, with extramarket correlation over 0.5.

Growth	*Value*
American Capital Advisors*	Ameritrust
Century Capital	Midatlantic National Bank
CIGNA Investment Management	Value Investors
Crocker Investment Management*	
Massachusetts Financial Services	
Mellon Bank	
Pittsburgh National Bank	
State Street Bank & Trust	
Tallasi Management Co.	

B. Managers categorized by EAI as "Asset Allocators"; categorized through cluster analysis, with extramarket correlation over 0.5

Growth	*Value*
Griffin Group	Stralem & Co.
HT Investors	
Neuberger & Berman	

* Correlation with other growth manager(s) exceeds 0.75.

analysis, with extramarket correlations in excess of 0.5. Four managers categorized only as "asset allocators" also appear to fall into the growth or value cluster, with correlations in excess of 0.5. However, most of the managers categorized as either asset allocators or designated as having a style that cannot be unambiguously categorized behave as expected: They do not join any cluster with correlations in excess of 0.5.

Comparing Apples with Apples

The magnitude of the correlation at each step of the clustering process has important implications. First, cluster analysis can identify similarities and differences in manager styles. For example, Putnam Advisory and Equitable Investment Management exhibit *highly* correlated results. By contrast, Brown Brothers joins the growth cluster with a paltry 0.13 correlation. Two key observations can be made:

- A comparison of the performance histories of Putnam Advisory and Equitable Investment Management is an "apples with apples" comparison. The high extramarket correlation suggests that the two have very similar styles of management. The performances of Equitable Investment Management and Brown Brothers cannot be compared with the same degree of confidence: Their investment styles are evidently different in substantive ways. Direct comparison is inappropriate unless there is a recognition that these managers have sharply different styles.
- The correlations provide clues about the diversification implicit in manager selection. If Putnam Advisory is already managing part of a pension plan, the sponsor may not appreciably broaden the pension plan diversification by also hiring Equitable Investment Management. By hiring one of the value managers, the sponsor can have a more direct impact on pension plan diversification, given the low correlations between growth and value managers.

We also conducted an examination of the original correlation matrix of risk-adjusted returns. The matrix is composed of 1,171 different correlation coefficients. The managers are classified according to growth and value investment styles based upon the cluster analysis (which involves moving Bankers Life to the value category). This results in 666 growth manager correlation coefficients and 210 value manager correlation coefficients. The remaining 835 correlation coefficients represent interstyle relations between managers across the two groups. The results were as follows:

- Within the growth and value groups, there were only a small number of negative correlation coefficients between managers of the same style. Within the growth group, 125 correlation coefficients (or 93 per cent) were positive. Within the value group, 73 correlation coefficients (again 93 per cent) were positive.
- Of these positive correlation coefficients within the two groups, the majority were significant. Of the growth correlation coefficients, 118 (or 87 per cent) were both positive and statistically significant. The same held true for 41 (or 53 per cent) of the value correlations. These numbers are well above the number that could be expected purely by chance.
- There were no statistically significant negative correlation coefficients within the two groups. The odds of this outcome occurring by chance are remote.
- Across the two groups, the results were less impressive. Of the 221 intergroup correlation coefficients, 38 (or 17 per cent) were significantly positive, while 18 (or 8 per cent) were significantly negative.

Are Growth and Value Complementary?

One important observation is the insignificant correlation between the growth and value clusters—−0.11. Common wisdom suggests that, when value managers are doing well, growth managers will lag the market, and vice versa. The observed neutral extramarket correlation between growth and value managers implies that the styles are not as complementary as commonly supposed. This is dramatically corroborated by these two facts: Of the 18 growth managers, just two exhibited negative extramarket correlations with the majority of the value managers; of the 12 value managers, only two exhibited negative extramarket correlations with the majority of their growth competitors.

If one manager is lagging the market, *someone else* must be beating the market. As a result, we would infer that there is some style of management that is complementary to *both* growth and value managers. This class of managers has not yet been isolated by the consultant community.

Implications

Our results suggest that cluster analysis can be helpful in the manager selection process. The judgmental classification of managers by consultants appears valid, but objective tools are required to isolate more than a set of broad categories. Cluster analysis can

- tell the sponsor or consultant whether a comparison of two or more managers is truly an "apples with apples" comparison;
- confirm (or contradict) the judgmental categories for managers; and
- isolate complementary managers with low (or, ideally, negative) extramarket correlations with existing managers.

The scope of this type of analysis could be broadened significantly. This particular analysis, for example, has been limited to equity managers, but it could prove just as useful for managers of other asset classes or managers using multiple asset classes (e.g., managers of strategic asset allocation strategies).

Future studies using cluster analysis might consider how a group of managers, whose investment styles are more ambiguous than those considered in this paper, might cluster together. Styles other than "growth" and "value" might be identified. Furthermore, this type of analysis might be used to observe the consistency, or lack thereof, of a manager's investment style over time. A multiple manager pension plan might wish to identify a niche for managers who actively and deliberately shift styles, rather than allowing recent relative performance to determine a pension plan's exposure to each style.

Finally, cluster analysis could be used in an *ex ante* fashion by pension plans. These plans might search for investment managers who do not readily cluster with the plans' existing managers. ■

Footnotes

1. This "fall from grace" of the balanced manager is detailed in "The Pension Sponsor's View of Asset Allocation," *Financial Analysts Journal*, September/October 1985, by Robert D. Arnott.
2. W. F. Sharpe, "Decentralized Investment Management," *Journal of Finance*, May 1981, pp. 217–235.
3. The quest for superior managers has been the subject of continuing debate focusing on the efficiency of capital markets; we have no intention of extending that discussion here.
4. For studies applying cluster analysis to stocks, see B. F. King, "Market and Industry Factors in Stock Market Behavior," *Journal of Business*, January 1966, pp. 139–191; J. L. Farrell, "Analyzing Covariation of Returns to Determine Homogenous Stock Groupings," *Journal of Business*, April 1974, pp. 186–207 and "Homogeneous Stock Groupings: Implications for Portfolio Management," *Financial Analysts Journal*, May/June 1975, pp. 50–62; and R. D. Arnott, "Cluster Analysis and Stock Price Comovement," *Financial Analysts Journal*, November/December 1980, pp. 56–62.
5. This subject of the cyclical rotation of performance among investment styles is only now beginning to receive serious, formal attention. See for example, R. D. Arnott and W. A. Copeland, "The Business Cycle and Security Selection Methods," *Financial Analysts Journal*, March/April 1985.
6. S. Jansson, "Can Style Switching Ever Become Respectable?" *Institutional Investor*, October 1985.
7. For a more detailed description of the algorithm used in cluster analysis, see King, Farrell, or Arnott, *op. cit.* In the interest of space, the authors felt that a detailed description of the algorithm was not warranted.
8. The form of these data varies among managers. For some managers, an equal-weighted composite of several portfolios is reported. For other managers a single representative account is used. In all cases, the returns are for accounts of tax-exempt clients.