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An Integrated Framework for Style Analysis and Performance Measurement

February 28, 2002

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Abstract:

In this paper, we propose an integrated framework for assessing the risk-adjusted performance of mutual fund managers. The methodology is designed so as to be consistent not only with modern portfolio theory but also with constraints imposed by practical implementation in a context where the presence of a variety of investment styles needs to be accounted for.

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(*) This paper was originally motivated by a research contract with the French financial newspaper, l'Agefi, who had invited the authors to suggest a consistent method for ranking French managers on the basis of their risk-adjusted performance. We acknowledge very useful comments from Olivier Maestracci. The author for correspondence is Noël Amenc. He can be reached at EDHEC, 393, Promenade des Anglais, BP 3116, 06202 Nice Cedex. Phone: (33) 4-93-18-99-66. Fax: (33) 4-93-18-32-74. E-mail address: noel.amenc@edhec.edu.

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Sound investment decisions rest on identifying and selecting portfolio managers who are expected to deliver superior performance. Measuring the performance of portfolio managers is, however, a challenging task, for at least two reasons.

First, performance must be evaluated in a risk-adjusted sense. Obviously, a manager generating marginally more return at the expense of significantly higher risk needs not necessarily be considered as a better manager. Risk-adjusted performance evaluation typically consists in using a factor model to compare the overall performance of a manager to the “normal” performance he/she should get from being exposed to rewarded sources of risk. Modern portfolio theory, and in particular the Capital Asset Pricing Model (Sharpe (1964)) and the Arbitrage Pricing Theory (Ross (1976)), provide us with some guidance with respect to what should managers’ normal returns, and therefore allow us to estimate managers’ abnormal returns (a.k.a. alphas), generated through managers’ unique ability to “beat the market” in a risk-adjusted sense due to market timing and/or security selection skills.

Another important problem is that professional investment managers follow a variety of approaches. Today, the notion of equity style management style is widely accepted in the investment community, and the concept of equity styles permeates the way most investors think about the stock markets and investment managers. Some managers, for example, held themselves out as “value fund managers” who look for companies with low absolute or relative P/E ratios or price/sales ratios, and/or above markets yields or book to market ratios that, in the managers’ opinion, are temporarily out of favor with other managers causing their stock price to be depressed. On the other hand, other managers see themselves as “growth fund managers” who look for companies which are growing rapidly and which are expected to show continued strong growth in earnings and revenue. Within these two broad styles, equity fund managers can further specialize by focusing only on companies of a certain size, the two most common market capitalization styles being small and large.

The purpose of this paper is to provide an integrated methodological framework for assessing the risk-adjusted performance of mutual fund managers. The methodology is designed so as to be consistent not only with modern portfolio theory but also with constraints imposed by practical implementation in a context where the presence of a variety of investment styles needs to be accounted for.

This paper is organized as follows. In section 1, we first describe a model introduced by Sharpe (1988, 1992) for assessing a fund’s effective style mix. In section 2, we show how the model can be applied to performance measurement at the cost of suitable adjustments. In section 3, we present a detailed practical methodology for portfolio performance evaluation. In section 4, we present an illustration of the methodology applied to a set of French equity portfolio managers. Finally, a conclusion can be found in section 5.

1. Return-Based Style Analysis

It is widely agreed that asset allocation accounts for a large part of the variability in the return on a typical investor's portfolio. This is especially true if the overall portfolio is invested in multiple funds, each including a number of securities. Asset allocation is generally defined as the allocation of an investor's portfolio among a number of major asset classes. Note that asset classes should be understood in a very general sense and might be better named "style allocation"; in particular it does not only consist of stocks and bonds, but also of various investment styles (e.g., large/small cap, value/growth, etc.).

Sharpe (1988, 1992) has introduced the following model to provide an objective assessment of a manager's effective style mix, as opposed to the manager's declared style mix. This is known as return-based style analysis. The model can be written as $R_{it} = w_{i1}F_{1t} + w_{i2}F_{2t} + \dots + w_{iK}F_{Kt} + e_{it}$, where R_{it} = (net of fees) excess return on a given portfolio or fund, F_{kt} = excess return on index j for the period t , w_{jk} = style weight and e_{it} is an error term.

Style analysis is a specific case of a (multiple) linear regression analysis (statistical terminology) and of a factor model (financial terminology). Such factor models are typically evaluated on the basis of their ability to explain the returns of the assets in question (i.e., the R_{it}). A useful metric is the proportion of variance "explained" by the selected asset classes, i.e., $R^2 = 1 - \frac{Var(e_{it})}{Var(R_{it})}$. The right-hand

side of this equation equals 1 minus the proportion of variance "unexplained". The resulting R-squared value thus indicates the proportion of the variance of R_{it} "explained" by the n asset classes/styles. On a technical note, the optimal style weights are actually obtained as the solution to a program of minimization of the variance of the residual term; this is the traditional approach of "least square estimation" (statistical terminology) or "tracking error minimization" (financial terminology).

What makes style analysis specific with respect to standard linear regression is that specific constraints are imposed to the coefficients so that they can be naturally interpreted as weights:

- Portfolio constraint: the coefficients are constrained to add up to one
- Positivity constraint: the coefficients w_{jk} are constrained to be positive

It should be noted that the presence of these constraints distorts standard regression results. In particular, confidence intervals for coefficients are no longer readily available in closed-form. These may however be numerically estimated (see Lobosco and DiBartolomeo (1997)).

2. Return-Based Style Analysis and Performance Measurement

Sharpe's return-based style analysis technique essentially divides the fund return into two components, "Style": $w_1F_{1t} + w_2F_{2t} + \dots + w_kF_{kt}$ (part attributable to market movements), and "Skill": e_{it} (part unique to the manager). The skill term itself may be attributable to (i) manager's exposure to other asset classes not included in the analysis; (ii) manager's active bets due to active picking within classes and/or class timing; or (iii) statistical error.

It is tempting to interpret the "skill" or total excess return term e_{it} in a style-analysis as a measure of abnormal return. There are two important caveats, however: First, the introduction of portfolio and positivity constraints in style analysis distorts the standard regression results. As a result, standard desirable properties of linear regression models do not hold. In particular, correlation between error term and benchmark asset may not be zero (Deroon, Nijman, Terhorst (2000)).

Furthermore, such an analysis does not provide us with an understanding of abnormal return, on a risk-adjusted sense. One needs to use instead a full-fledged multi-factor model, which provides a measurement of a fund abnormal return as the excess mean return over the "normal return" given by the following relationship: $\alpha_i = E(R_i) - r_f - \sum_{k=1, \dots, K} b_{ik} [E(R_{F_k}) - r_f]$, where α_i represents the abnormal performance of the fund, R_i is the (net of fees) return on a given portfolio or fund, r_f is the risk-free rate, b_{ik} is the sensitivity of the fund to factor k and F_k is the return on factor k for the period.

While this equation, a straightforward generalization of the CAPM security market line consistent with Ross's Arbitrage Pricing Theory, provides us with a theoretically satisfying answer to the problem of risk-adjusted performance measurement, it does not contain any insights on the choice of the factors in practice.

There are actually four types of factor-models.

- Implicit Factor Model. In this approach, some factor analysis (e.g., a principal component analysis) is performed to statistically extract the factors from the return's time-series. It is perhaps the best approach because it is free of problems such as inclusion of spurious factors and omission of true factors. However, factors may not be easily interpretable.
- Explicit Macro Factor Model. In this approach, macro-economic variables are used as factors. For example (Chen, Roll, Ross (1986)) use inflation rate, growth in industrial production, spread long-short treasuries, spread high-low grade corporate interest rate.

- Explicit Micro Factor Model. In this approach, micro-economic attributes are used as factors. A popular example of such model is BARRA.
- Explicit Index Factor Model. In this approach, stock market indices are used as factors. This is consistent with the idea of using portfolios returns as factors. The most popular example of this approach is the CAPM (Sharpe (1964)), where the return on the market portfolio, proxied by a broad-based index is used as a factor. The idea of using “mimicking portfolios” as a proxy for true unknown factor is also present in Fama and French (1992).

In this context, we suggest to address both problems of shortcomings of style analysis (distortion of linear factor model results because of the presence of constraints, and lack of proper risk-adjustment) by using an Index Multi-Factor Model, which can be written as:

$$R_{it} - r_{ft} = \mathbf{a}_i + \mathbf{b}_{i1}(F_{1t} - r_{ft}) + \mathbf{b}_{i2}(F_{2t} - r_{ft}) + \dots + \mathbf{b}_{iK}(F_{Kt} - r_{ft}) + e_{it}.$$

This equation can be regarded as a weak-form of style analysis, consisting in relaxing the positivity and portfolio constraints, and including a constant term in the regression. This factor model is similar in spirit to the one used by Elton et al. (1993) to assess managers' fund performance.

From the standpoint of asset pricing theory, using an index model is also consistent with empirical evidence that there are factors other than the return on the market portfolio that explain the cross-section of expected returns. In the absence of control for style exposure, seemingly superior risk-adjusted performance can easily be achieved by a manager just through a higher exposition to a rewarded source of risk. For example, a manager holding a portfolio under- or over-invested in small cap or large cap stocks is likely to receive an equilibrium premium as a reward. If the manager's performance is solely measured in terms of his portfolio's beta with respect to broad-based market risk, then it can easily be under or over-stated. Multi-factor models, justified through equilibrium (see Merton's CCAPM (1973)) or arbitrage (see Ross' Arbitrage Pricing Theory (1976)) arguments have the potential to explain, or at least account for, differential in style returns.

From a practical standpoint, this approach therefore allows us to address the question of benchmarking and performance measurement in a unified setup: once suitable indices have been selected, they can be used both for return-based style analysis (strong form of style analysis with positivity and portfolio constraints) and abnormal return measurement (weak form of style analysis).

3. Proposition of Methodology for Risk-Adjusted Performance Measurement

In this section, we now describe how the method may be implemented in practice.

Step 1: Select a Set of Categories

We believe that return-based and decomposition-based style analysis work best when combined. Therefore, when possible, we suggest the use of a classification scheme based on unambiguous categories, and then on investment styles such as inferred from return-based style analysis. More specifically, we suggest to use decomposition-based for observable attributes, e.g., geographic zone. On the other hand, we suggest to use return-based for non observable characteristics, in particular investment styles, as opposed to using managers' self-proclaimed styles, about which information may be missing or dubious.

For example, one may first distinguish the categories "equity", "fixed-income", and "diversified". We may then sort funds into geographical zones. Finally, we may use return-based style analysis and cluster analysis (see step 3 below) to sort funds within management styles for each zone. For equity funds, these management styles may include for example growth, value, small cap and multi-style. For fixed-income funds, management styles may include Treasury, Corporate Investment Grade and High Yield. One may decide to sort funds into different categories according to maturity.

Step 2: Select a Set of Indices to Perform Return-Based Style Analysis

We need to select for each sub-category a set of indices that will be used for benchmarking funds' returns in a return-based style analysis. In principle, this should be an easy task as there are actually a number of competing style index providers to choose from both equity and fixed-income universes. In particular MSCI provides an exhaustive set of style indexes for all major stock markets worldwide.

One serious problem, however, is that style indexes come in very different shapes and forms. In particular Amenc and Martellini (2003) document that a profound heterogeneity in the set of assets under consideration, as well as some heterogeneity in the index construction methods, result in some dramatic heterogeneity in the returns of competing equity style index providers. For example, for the month of February 2001, the return on the S&P 500 BARRA Growth Index was 11.75% while that of the Dow Jones for the same style was –

18.36%, a dramatic. As an attempt to address some of these problems, Amenc and Martellini (2003) suggest various methodologies designed to help extract a “pure style index”, or “index of the indexes”, from competing index returns and argue that these “pure style indexes” may improve the reliability of performance estimates.

Step 3: Form Peer Groups

We then suggest to represent each fund by a vector of the fund's style weights, and perform cluster-based peer grouping by minimizing intra-group and maximizing extra-group distance between funds, where distance is defined in terms of an appropriate metric in the space of fund's style weights. Cluster analysis routines are readily available in statistical softwares such as SAS. The number of clusters can be exogenously imposed, so as to ensure that a reasonable number of different classes be obtained.

Step 4: Perform a Risk-Adjusted Analysis of each Fund's Performance

We finally suggest to measure risk-adjusted performance as the intercept (with t-statistic for assessment of statistical significance) of an unconstrained regression of the fund's excess return on the different indices' excess return. In order to avoid over-fitting and multi-collinearity problems, an extra-step might involve the selection, for each fund, of the subset of sub-indices which have been identified as statistically significant in explaining the fund return, where statistical significance can be assessed using the numerical procedure introduced by Lobosco and DiBartolomeo (1997). If needed, a ranking can then be performed for each group on the basis of alphas.

4. Application

We have implemented the method on a database of French equity, fixed-income as well as diversified managers put together by Europerformance, a French-based subsidiary of Fininfo group, one of the world leaders in terms of financial data. This analysis has actually been used by l'Agefi, a French financial newspaper, which had invited the authors to help them design and implement a new method for ranking French portfolio managers on the basis of their risk-adjusted performance, as opposed to relying on simple measures such as the Sharpe ratio.

In table 1, we display the results from style and cluster analysis for the subset of French equity managers. For this analysis, we have decided to use the following

set of MSCI indexes as regressors: MSCI France Value, MSCI France Growth, MSCI France Small Cap, MSCI Europe Value, MSCI Europe Growth, MSCI Europe Small Cap, MSCI World Value, MSCI World Growth, MSCI World Small Cap.

Table 1: Average style weights for French equity managers. This table features the average value of the style weight for each cluster in each geographical zone.

Equity Portfolio Managers - France					
	I1	I2	I3	Number of Funds	Style Interpretation
	MSCI France Value	MSCI France Growth	MSCI France Small Cap		
cluster1	0.5	0.5	0.0	36	large (growth+value)
cluster2	0.5	0.3	0.2	107	multi-style
cluster3	0.1	0.6	0.3	7	growth
cluster4	0.1	0.3	0.6	50	small
cluster5	0.4	0.1	0.4	28	multi-style
cluster6	0.3	0.4	0.3	27	multi-style

Equity Portfolio Managers - Europe					
	I1	I2	I3	Number of Funds	Style Interpretation
	MSCI Europe Value	MSCI Europe Growth	MSCI Europe Small Cap		
cluster1	0.0	0.8	0.2	28	growth
cluster2	0.0	0.2	0.8	77	small
cluster3	0.5	0.1	0.4	68	multi-style
cluster4	0.4	0.6	0.0	91	large (growth+value)
cluster5	0.2	0.3	0.4	187	multi-style

Equity Portfolio Managers - International					
	I1	I2	I3	Number of Funds	Style Interpretation
	MSCI World Value	MSCI World Growth	MSCI World Small Cap		
cluster1	0.8	0.1	0.1	51	value
cluster2	0.2	0.1	0.8	75	small
cluster3	0.0	0.7	0.3	55	growth
cluster4	0.4	0.4	0.2	127	multi-style
cluster5	0.4	0.1	0.5	112	multi-style
cluster6	0.1	0.3	0.6	148	small

From table 1, it appears that the segmentation in terms of style is apparent for equity portfolio managers who invest internationally. On the other hand, for French equity portfolio managers who invest in local markets (France and Europe), the most salient distinction is a small cap versus large cap distinction. This suggests the concept of equity styles has not yet really permeated the way French managers invest in French equity markets. On the other hand, when they invest in international markets, French managers seem to specialize along the growth versus value as well as the small versus large dimensions. Interestingly,

even though we do not report such results here in the interest of brevity, a similar pattern is found for bond portfolio managers. In particular, it appears that French bond portfolio managers invest almost exclusively in Treasury bonds when they invest in the Euro-zone. When they invest abroad, on the other hand, they seem to invest in all rating classes.

Using $\frac{Var(e_i)}{Var(R_i)}$ as a proxy for the percentage of the performance that emanates from the manager active bets, we have actually obtained that a significant fraction of managers' returns is unexplained by a passive exposure to various asset classes accounted for in the analysis. Depending on the category under consideration, the average value for the R-Squared varies between 38.12% and 71.57%, while the standard deviation is between 14.17% and 33.45%.

These results, as well as results on alphas obtained as explained in step 4 from section 3 are summarized in table 2.

Table 2: Performance analysis of French equity managers. This table features various performance measures consistent with the analysis from step 1 to step 4 in section 3 for the data base of French managers.

	Equity France	Equity Europe	Equity International	Bond Euro	Bond International
Average yearly alpha	-2.01%	0.22%	-1.24%	-0.88%	1.95%
Standard deviation alpha	6.15%	5.95%	14.38%	2.77%	4.69%
Number of positive alphas	62	244	203	55	148
Number of negative alphas	193	207	365	400	104
Average R ²	70.45%	71.57%	61.47%	38.12%	59.04%
Standard deviation R ²	14.17%	13.39%	19.75%	33.45%	30.00%
Total number of funds	255	451	568	455	252

From table 2, it appears that more French managers have negative, as opposed to positive, risk-adjusted performance, with a relatively large dispersion of such alpha measures. Of course, some caution should be exercised in the interpretation of these results, as some of these alphas are not statistically significant. On the other hand, the method ensures that a proper multi-index benchmark is applied to measure such risk-adjusted performance.

5. Conclusion

In order to provide a consistent methodological framework for assessing the risk-adjusted performance of mutual fund in the presence of a variety of investment styles, we suggest the use of two important tools from modern portfolio theory, return-based style analysis, which allows us to form static peer groups of comparable managers, and also check for their dynamic style consistency, and a customized multi-factor model to estimate superior risk-adjusted performance (alpha) within each group. We believe this approach achieves a balanced trade-off between practical and conceptual consistency.

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