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Common Factors in Mutual Fund Returns

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COMMON FACTORS IN MUTUAL FUND RETURNS

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A great deal of the literature in financial economics contains the assumption that returns are a linear function of a set of observable or unobservable factors. The specification of the variables in the linear process (known as the return-generating process) is one of the key issues in finance today.

The return-generating process is an important building block in asset pricing models, portfolio optimization models, mutual fund evaluation, and event studies. For many purposes (such as in developing asset pricing models and evaluating mutual fund performance), it is important to separate systematic from non-systematic factors. There have been numerous attempts to examine the number and type of systematic factors in equity returns.

Approaches to identifying the return-generating process include purely statistical models such as those of Dhrymes, Friend and Gultekin (1984), Elton and Gruber (1984), Roll and Ross (1980), and Lehmann and Modest (1988), and models that a priori specify and test a set of fundamental factors and/or portfolios such as those of Chen, Roll and Ross (1986), Fama and French (1992, 1993), and Burmeister, et al. (1986, 1987 and 1988).

The purpose of this study is to determine the systematic factors by examining mutual fund returns. There are two reasons why it might be more informative to work with mutual fund returns rather than either security returns or a portfolio of security returns constructed on a mechanical basis.

The first reason arises from modern portfolio theory. One important implication of modern portfolio theory is that, given a belief about systematic factors, an investor should select an exposure (beta) to each factor, a level of expected risk-adjusted return (alpha) and a level of residual risk (residual variance).[1] The mutual fund industry has an incentive to offer an array of exposures to systematic factors in order to meet investors' differing objective functions. If mutual funds all choose similar sensitivities to a factor, a mutual fund deviating from the norm should attract substantial investor interest and cash inflow. Thus, investors' objectives and mutual funds' incentives should result in a spread of sensitivities to factors viewed as systematic. Therefore, mutual funds provide a logical way to obtain portfolios which have a spread on the characteristics of interest while smothering much of the noise inherent when a model is fitted to individual security returns.[2] Employing mutual fund data should lead to better separation in the sensitivities to characteristics than forming portfolios on the basis of a proxy characteristic (e.g. size) chosen to obtain separation.

A second reason arises when we concern ourselves with the study of mutual fund performance. To examine mutual fund performance in a meaningful way, one needs to specify a return-generating process. Much of the literature uses an assumed return-generating process to evaluate mutual funds. This approach started with Jensen's (1966) early work (which assumed a one-index return-generating process) up through the work of Elton, Gruber

[1] See, for example, Elton and Gruber (1992) or Fama (1993).

[2] There is one complication that arises in using mutual fund data to test for systematic influences: the tendency of mutual funds to hold stocks which are held by other funds may affect our results. We test and adjust for these influences.

and Blake (1996a), which assumed a four-index model. As shown in Elton, Gruber, Das and Hlavka (1993), the choice of the return-generating process can affect the performance attributed to management. What better way to find these systematic influences that affect mutual funds than by studying mutual funds themselves?

I. SAMPLE

We use data on mutual funds and indexes in this study. All mutual fund data were supplied by Investment Company Data, Inc. (ICDI).[3] We initially selected all mutual funds that existed as of January 1979 and that had monthly ICDI return data through December 1993. Such a sample clearly has survivorship bias, but for the purposes of determining the important factors affecting returns, survivorship bias should be unimportant.[4] There were 351 funds (excluding money market and municipal bond funds) that existed in the ICDI database over this period. From this set we eliminated bond, option, precious metal, international, and index funds. This left us with a set of 267 funds. We divided these funds into three 89-fund subsamples (group A, group B and group C). Having multiple samples allows us to test the robustness of results and in particular to see whether results derived on one set of data are generally applicable.

The three subsamples were selected so that each subsample had the same number of funds with a given objective and so that funds from any fund family (e.g. Fidelity) were

[3] The accuracy of the data is discussed in Elton, Gruber and Blake (1996b).

[4] A problem would result only if funds which did not survive were the only funds affected by some factor so that this factor would not be uncovered in this study.

spread evenly across the three groups. Having the same number of funds with a given objective in each group makes the subsamples reflective of the overall distribution of objectives. Spreading any fund family across all groups helps to ensure that the factors we pick up are not associated with a fund family's style.

The indexes we use fall into two groups: those that are publicly available, such as the S&P 500 index, and those that we constructed from CRSP monthly return data, such as a natural resources index. We will discuss the detailed construction and characteristics of these indexes in later sections.

II. ANALYSIS

An index model that captures all of the factors affecting the covariance between securities should result in the residuals from the model for any fund being uncorrelated with the residuals for any other fund. The indexes that principally affect returns on mutual funds should be the influences common to all securities. Therefore, if we are comparing two multi-index models, the one that results in the smaller residual correlations better captures the common factors affecting security returns. An inadequate model can result in either positive or negative residual correlations. Either sign for correlations is equally bad. Since it is the size of residual correlation rather than the sign that affects the adequacy of a model, we examine the distribution of the absolute values of the residual correlations to evaluate model accuracy.

A. The Base Model

Table 1 presents these results for a number of different models. Let's start by examining Panel A. Panel A presents results based on the absolute values of the correlations between residuals for three models — a zero-index model (where the "residuals" are simply the excess returns, i.e., the fund returns minus the CRSP SBBI 30-day T-bill rate), a standard one-index model, and a four-index model (called the "base" model) that we have employed in previous research.[5]

The one-index model uses the excess return on the CRSP SBBI S&P 500 total return index as the single index. The base four-index model adds to the S&P 500 index (measured in excess-return form): (1) a bond market index (a par-weighted combination of the Lehman Brothers aggregate bond index and the Blume/Keim high-yield bond index in excess-return form; (2) a small-cap minus large-cap index (the average of the Prudential-Bache small-cap growth and value indexes minus the average of their large-cap growth and value indexes); (3) a growth minus value index (the average of the Prudential-Bache large-, mid- and small-cap growth indexes minus the average of their large-, mid- and small-cap value indexes).

The S&P 500 total return index and the small minus large index were selected because they have been shown to be related to security returns in a number of studies. Growth minus value was selected as the third index in our base model. Both growth minus value and market-to-book have been shown to be importantly related to security returns. However,

[5] We examined different combinations of the indexes from our four-index model in two- and three-index versions and found that they did not perform as well as the four-index model. Hence, we do not report them.

because growth minus value is highly correlated with returns on portfolios separated by their market-to-book ratio, we included only one of the indexes. Shortly we will test both market-to-book and growth minus value to try to get insight into which is the more fundamental index. A bond index was included because many mutual funds that have "common stock" as their objective often hold bonds in their portfolios. While a bond index may or may not be important in explaining return patterns on common stocks, it is clearly important when bonds can be included in the portfolios under study.

As shown in Panel A of Table 1, the mean absolute value of the residual correlations becomes smaller as we move from the zero-index to the one-index model to the base four-index model. The means are statistically different using a simple *t* test. Of more importance, each model with more indexes dominates the models with fewer indexes using first-order stochastic dominance. Since first-order stochastic dominance only assumes that larger correlations are inferior to smaller correlations, this is a particularly powerful test.

Since the four-index model outperforms the models with fewer indexes, the question remains as to whether we can find a fifth index which will result in still lower correlations between residuals.

Before we turn to this question, let us examine the spread in sensitivities of the funds in our sample to each of the indexes in our model. As discussed in the introduction, a justification for using mutual fund data is a belief that we will get a substantial spread on sensitivities. To judge this, we need a comparison group. Since size is often used as a criterion for forming portfolios to test return-generating processes, we selected the ten size deciles from the monthly CRSP Stock Indices file as an alternative set of portfolios with which to judge the dispersion of sensitivities. Table 2 presents the standard deviation of sensitivities and the interquartile range of sensitivities for our full sample of mutual funds as well as for the CRSP deciles. It is clear from this table that mutual funds not only show dispersion on the sensitivities to each index, but also (with one exception) they show more dispersion than the CRSP size deciles. The one exception is the sensitivity to the size index. This is logical, since the CRSP deciles were selected to maximize dispersion on the index. However, even here the mutual funds show a high degree of dispersion consistent with the dispersion of mutual fund sensitivities on other indexes. Mutual funds are presenting investors with alternative sensitivities to the indexes in our model, and mutual funds thus present a meaningful way to examine a return-generating process.[6]

B. A Fifth Index

In this section we explore whether a fifth index should be added to the base model. The first candidate we examine for a fifth index is derived from the data itself. For each group we performed a maximum-likelihood factor analysis on the residuals from the base (four-index) model and extracted the one-factor solution. For any group, this represents the best index that can be found for explaining the residual covariances for that group. No other

[6] Table 2 also shows that mutual funds have more dispersion with respect to a fifth index (a mutual fund growth index) which is introduced in the next section.

index could perform better for the group from which the factor is extracted. However, the factor will pick up influences that may be unique to the group from which it is extracted, as well as more general systematic influences. To eliminate the effect of unique influences, the factor derived from group A was used to explain the correlation in group B, the factor from B to explain C, and the factor from C to explain A.

As shown in panel B of Table 1, when the fifth index is extracted via factor analysis, there is a very large improvement in the residual correlation estimates. The results show stochastic dominance over the four-index model, and the difference in the average absolute values of the correlation coefficients is significant at the .01 level.

The question remains as to whether we can find an alternative fifth index that works as well or better than the factor approximation and that has an economic meaning. We tried two approaches. One involved forming other portfolios of stocks and the second involved using data from mutual funds (rather than from passive portfolios of stocks).

For the first of these approaches we formed portfolios of stocks that represented sectors of the economy. We examined a financial sector, a utility sector, a high tech sector, metals stocks, foreign stocks, and a natural resource sector. These were selected because of their inclusion in other studies. None of the five-index models using a sector factor outperformed the four-index base model at a significant level, and all were outperformed by the five-index model containing a factor (base model plus factor) at the .01 level of significance. In Table 1, Panel B, we present the results for the best of these models — the model using a natural resource index.[7]

Having failed to find a sector index which performed adequately, we decided to examine an index which represented mutual fund returns themselves rather than security returns. We selected the Morningstar growth mutual fund index (an equally weighted index of the funds Morningstar classifies as growth) as our fifth index. This growth index was selected because this is our largest category of funds and because residuals from the four-index model are smaller for income funds than they are for growth and aggressive growth funds. We reformulated the Morningstar index by regressing it against the four-index base model and used the residuals as our mutual fund growth index, which we refer to as MGO.

The first fact to notice from Panel B of Table 1 is that the introduction of the mutual fund growth index (MGO) results in a model which outperforms the four-index base model. (The difference in average absolute values is statistically significant level at the .01 level.) When we compare the five-index model using the mutual fund growth index to the model using the factor as the fifth index, we find that the results are virtually indistinguishable. No technique shows stochastic dominance over the other in any of the three samples, and the mean differences in absolute values of correlation coefficients are not statistically different. Furthermore, the mutual fund growth index is highly correlated with the factor extracted by factor analysis in the five-index base-plus-factor model. The correlation between the factor

[7] This index was formed as an equally weighted portfolio of 38 natural resource stocks contained in the S&P 500 index and made orthogonal to the S&P 500 index.

scores and the growth index is .86, .88 and .82 for the three samples we examined. Since a mutual fund growth index improves results and is economically identifiable, it is worthwhile to try to understand why it enters and what its relationship is to the growth-minus-value index in our base four-index model.

The base four-index model includes the difference between a growth and a value index as one of the indexes. One possibility for the improvement of adding the mutual fund growth index is that when we use the difference in growth and value we are implicitly assuming they are equally important. Perhaps the five-index model leads to improvement because an unequal combination of the Prudential Bache growth and value indexes represents the factor affecting returns. This can be tested by adding either the Prudential-Bache value or growth index to our base four-index model. When we did this, the results were not improved over the base four-index model. Perhaps the base model could be improved by a better formulation of the growth-value variable.

There are two generic types of value and growth indexes. One type classifies firms on the basis of fundamentals (e.g., Prudential Bache and Wilshire). The second type uses value-to-book (e.g., Barra, Fama and French and Russell). Which type performs better is tested in Panel C of Table 1, where we compare the residual correlations using Pru-Bache indexes with those of two types of indexes that classify by market-to-book ratio (Barra and

Russell).[8] The four-index model using the Pru-Bache indexes results in a smaller average absolute value of residual correlations than do the four-index models using market-to-book ratios. These differences are statistically significant using a simple *t* test and using stochastic dominance tests. Thus a fundamental growth-value index is preferable to one that classifies firms by their market-to-book ratios.

Why else could adding an index of growth funds improve the ability to explain the correlation structure? There are two additional explanations. First, the index representing growth in the base model could be imperfectly measured. Potentially, both market-to-book and growth-value may be proxying for a more fundamental factor. Second, many mutual funds have a large number of common holdings, and it is possible that we are simply picking up a factor that captures common holdings. We now turn to an examination of whether either of these explanations might be correct. We start by examining the impact of common holdings on residual correlations.

C. Estimating the Effect of Common Holdings

At this point, the question remains as to how much of the correlation between mutual fund returns is due to common holdings as opposed to systematic factors affecting stock prices. Many mutual funds tend to hold the same stocks, and obviously the correlation

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[8] In each alternative four-index model, we use the difference between a growth and a value index as the fourth index. Barra separates the firms in the S&P 500 into two groups (growth and value) based on their market-to-book ratios. For the Russell growth-value index, we use the Russell 1000 value and growth indexes; these are constructed by splitting the largest 1000 stocks into two groups by market-to-book ratios.

between the parts of their holdings which are in common is perfect (equal to one). Unless factors in the return-generating process capture the returns on a portfolio of these common holdings, common holdings will explain part of the residual correlation between funds.

To see this, assume for the moment that the residual variance for each stock i ($Var(e_i)$) is the same, i.e., $Var(e_i) = CVAR$ for all i, and that the residual covariance between each pair of stocks i and j ($Cov(e_i e_j)$) is the same, i.e., $Cov(e_i e_j) = CCOV$ for all i and j. Then the covariance of the residual returns between two funds A and B ($Cov(e_A e_B)$) can be represented as

$$Cov(e_A e_B) = \sum_{i \in S} X_{Ai} X_{Bi} CVAR + \sum_{i} \sum_{\substack{j \\ j \neq i}} X_{Ai} X_{Bj} CCOV \qquad (1)$$

where S is the set of stocks held in common and X_{Ai} represents the proportion invested in stock i by fund A.

Recognizing that the set notation can be dropped since $X_{Ai} X_{Bi} = 0$ for i not in S and rearranging equation (1) by combining summations and adding and subtracting $\sum_{i} X_{Ai} X_{Bi} CCOV$ yields:

$$Cov(e_A e_B) = \sum_{i} X_{Ai} X_{Bi} [CVAR - CCOV] + \sum_{i} \sum_{j} X_{Ai} X_{Bj} CCOV \qquad (2)$$

Now funds might not be 100 percent invested in common stock. Equations (1) and (2) embody the assumption that all residual fund covariance comes from stock holdings.[9] We can scale equation (2) by the percentage of stock held by each fund :

$$\frac{Cov(e_A e_B)}{\sum_i X_{Ai} \sum_j X_{Bj}} = CCOV + [CVAR - CCOV] \times \left[\frac{\sum_i X_{Ai} X_{Bi}}{\sum_i X_{Ai} \sum_j X_{Bj}} \right] \quad \textbf{(3)}$$

Equation (3) can be estimated as a cross-sectional linear regression model:

$$\frac{Cov(e_A e_B)}{\sum_i X_{Ai} \sum_j X_{Bj}} = \gamma_0 + \gamma_1 \left[\frac{\sum_i X_{Ai} X_{Bi}}{\sum_i X_{Ai} \sum_j X_{Bj}} \right] + \eta_{AB} \quad \textbf{(4)}$$

where η_{AB} is a random error term.

Estimates of the common residual covariance between stocks (*CCOV*) and the stocks' common residual variance (*CVAR*) from any model can be computed directly from the regression estimates of γ_0 and γ_1 in equation (4).

The above analysis assumes that the residual covariance between each pair of stocks is the same and that the residual variance of all stocks is the same. However, we might expect the residual variance and covariance for stocks held by aggressive growth funds to be

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[9] While this assumption is not strictly true, it should be a very good approximation. As shown in Blake, Elton and Gruber (1993), once the effect of a general bond return index is removed, correlations between the residuals of bond portfolios are small, and we have removed a bond index effect here. In addition, the variances of the residuals for bond portfolios after a bond index effect is removed are quite small relative to those for stock portfolios.

different than the residual variance and covariance for stocks held by income funds. We divided our sample funds into three types — aggressive growth (AG), growth (G), and income (I) — and allowed the estimates of stock residual risk and covariance to be different for each type of fund.

Equation (4) can be used to estimate the residual variance of the returns on stocks and the residual covariance between the stocks in any fund type or any two fund types. To estimate this equation, we need to know the composition of the portfolio of each fund to which it is fit. Because of the difficulty of obtaining composition data, we obtained data only as of one date, December 1992, and for the funds in only one of our subsamples (group A). To the extent that the percentages of stocks held in common on this date were not representative of the whole of our sample period, this should bias the results against finding that common holdings help explain the covariance between funds. The source of our composition data was Morningstar. Group A contained 89 firms. Eleven of these firms were eliminated because we could not obtain composition data, or because their investment policy was outside the three groups described above, or because the data on fund composition contained inconsistencies or was incomplete. We call this restructured version of group A "group D."

Before we turn to our analysis using equation (4), let us examine the amounts of common holdings in group D. Table 3 shows the distribution of common holdings within and between types of funds with different policies. The median common holdings range from

1.3% to 5.6%, depending on the sample. For four of the samples, the 75th percentile is greater than 5%. This is substantial, given the residual correlations we are observing.

Table 4 shows the estimates of covariances and variances of individual securities for each fund type and across fund types obtained from the regression employing equation (4). The estimates in Panel A using the residuals from our base four-index model are consistent with what we expect to find and, in most cases, are statistically significantly different from zero.[10] The pattern of the variances of the residuals shows that residual variance is highest for the stocks held by aggressive growth funds, next highest for stocks held by growth funds and much lower for stocks held by income funds. The residual variances of stocks held by two different types of funds show a similar pattern, with the stocks held by both aggressive growth and growth funds having a higher residual variance than those stocks held by both aggressive growth and income funds, which in turn have a higher residual variance than those stocks held by both growth funds and income funds. The ordering of the residual risk seems rational, as we would expect aggressive growth funds to have stocks with higher residual risk than those held by growth funds and we expect the lowest residual variance

[10] As a check on the regression estimate, we examined equation (3) only for those funds which had common holdings close to zero. For those funds, within any fund type or pair of fund types, the average scaled residual covariance between the funds should be equal to the residual covariance between stocks held by the funds. The results from this procedure produced estimates of residual covariances consistent with those obtained from the regression procedure described above. For example, for the four-index model the estimate from pairs of funds of type AG was .6464 for the regression and .5547 for zero holdings; for pairs of types AG and G it was .2535 for the regression and .2676 for zero holdings; for pairs of types AG and I it was .1196 for the regression and .1277 for zero holdings. This consistency gives us additional confidence in the regression estimates.

from those held by income funds. The covariances estimated in Panel A of Table 4 also fit a reasonable pattern, with the highest covariance found between stocks held by aggressive growth funds and the next highest between stocks held by both aggressive growth and growth funds. Examining the estimates for the five-index MGO model shown in Panel B, we find broadly similar results with one exception being that the estimated covariances are not statistically different from zero. We shall discuss the implication of this in a later section.

If we substitute an estimate of the stocks' common residual variance and common residual covariance into equation (2) along with a pair of funds' investment proportions, we obtain an estimate of the residual covariance between any pair of funds. This will allow us to correct residual covariances for the impact of common holdings.

D. Is It Common Holdings or Another Factor?

The analysis in section B indicated that the MGO index contributed to explaining the covariance between securities. In this section, we present further evidence on why the MGO index is important. The question we shall address is to what extent is the MGO index picking up common holdings and to what extent is it an independent influence. We present two approaches to examining the effect of common holdings. The first examines the relationship of the residual covariance between funds predicted by both the MGO index and common holdings. The second looks at the absolute value of the correlation between residuals from a four-index and a five-index model with and without removing the estimated effect of common holdings.

The residual covariance between two funds A and B due to the MGO index is:

$$\beta_{A,\mathrm{MGO}}\,\beta_{B,\mathrm{MGO}}\,Var(\mathrm{MGO}) \tag{5}$$

If common holdings are the sole reason for a covariance between fund residuals, then the covariance would be equal to the first term on the right-hand side of equation (2). Using our estimates for variance and covariance of security residuals from Panel A of Table 4 and the percentages held in common by all pairs of funds, and applying the first term on the right-hand side of equation (2), results in an estimate of residual fund covariance due to common holdings. When we regress this estimate on the residual fund covariance due to the fifth index (expression (5)), we get an adjusted R^2 of .22. Thus, the MGO Index comes in, in part, because it picks up the effect of common holdings.[11] However, the MGO Index may contain independent information and common holdings may contain independent information. To test this we must examine the impact of common holdings on the residual correlations from the four-index and five-index models.

In Table 5 we present the distribution of absolute values of residual correlation coefficients for different return-generating processes with and without a correction for common holdings. Let's start by examining the residual correlation distribution from the

[11] Similar results are obtained when the fifth index is constructed from a one-factor factor analysis of the residuals from the four-index model. In this case the correlation is .13 rather than .22.

four-index model shown in Panel A of Table 5. Adjusting for common holdings lowers the average absolute value correlation from .130 to .119. Not only is the difference statistically significant, but the adjustment shows stochastic dominance across the cells in the table. Common holdings have a major impact on reducing the absolute values of correlations of residuals from the four-index model.[12]

When we examine the residual correlation from a five-index model (adding MGO) (shown in Panel B of Table 5) without any adjustment for common holdings, we find that the average absolute value of the residual correlations is reduced below that found for the four-index model with adjustment for common holdings. The results are statistically significant at the .01 level and show stochastic dominance. Clearly, then, the MGO index introduces information not captured by common holdings. The question remains as to whether common holdings add additional information when the five-index model is used. Examining Panel B, we see that employing the correction for common holdings reduces the absolute correlation between residuals. While the difference is statistically significant, the distribution does not show stochastic dominance. However, using the correction for common holdings reduces the largest absolute values of residual correlations.

These results are consistent with those presented earlier in this section. When a four-

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[12] The effect of common holdings is estimated by using the first term on the right-hand side of equation (2) along with estimates of residual variance and covariance of securities from panel A of Table 4 and the percentages of stocks in common. This estimate of the funds' residual covariance due to common holdings is subtracted from the funds' actual residual covariance to adjust for the effect of common holdings.

index model is used, an adjustment for common holdings improves results markedly. When a fifth index is introduced, adjustment for common holdings reduces the residual correlation only a small amount. The introduction of an index based on actual mutual fund performance captures a large part (but not all) of the improvement introduced by explicitly taking common holdings into effect. The fifth index partially accounts for common holdings and partially adds a different influence.

E. Are Five Factors Enough?

In this section we present evidence which suggests that our five-factor fundamental model is a sufficient description of the return-generating process. Our evidence consists of four parts: 1) an examination of cross-sectional estimates of covariance; 2) an examination of how much of the remaining covariance is due to common holdings; 3) forecasts of correlations based on the sufficiency of the model; and 4) a comparison of the fundamental model with multi-index models based on factor analysis.

Covariance between common stock residuals comes about because of randomness and because of omitted factors. If the model captured all common influences, then the covariances of the residuals between stocks would average zero, covariances between stock residuals due to randomness would tend to cancel out in a portfolio, and the only reason funds would have a residual covariance would be common holdings. When we examine Table 4, Panel B, all estimates of the residual covariance estimates between securities for the five-index model are not statistically different from zero except for two cases: the aggressive growth and the aggressive growth and income samples. In these two cases they are significant, but with opposite signs. This is a strong indication that five indexes capture all common influences.

A second way to see if five factors are enough is to compare the unexplained covariance between funds assuming zero covariances between securities (all common influences are captured) with one that assumes they are non-zero. We calculated two estimates of covariance, one assuming the estimates shown in Panel B of Table 4, and one assuming that the best estimate of the covariance between securities is zero. The results are shown in Panel B of Table 5 under the headings "Regression Estimate" and "Zero-Cov Estimate." The estimates from the five-index growth model are more accurate when zero covariance between security residuals is assumed. The results show stochastic dominance and are significant at the .01 level. Thus, assuming the covariance between securities is zero and that all common influences are captured by the five-index growth model leads to the better estimates.

Another way to look at the data in Table 4 is to ask how much of the forecasted residual covariance is due to common holdings and how much is due to any remaining covariance between individual securities. With the five-index model, on average the proportion of the forecasted residual covariance due to common holdings is 60 times that due to the residual covariance between securities. For the group with the largest estimate for the residual covariance between securities, aggressive growth with other aggressive growth, the proportion of the estimated residual covariance due to common holdings is 80%. This is strong evidence that five indexes are enough to capture common influences.

A final way to examine if we have captured the important common factors is to compare our results with those from a purely statistical extraction of factors. We performed a maximum-likelihood factor analysis on the variance-covariance matrix of the funds' excess returns for each of our three samples. We extracted one to eight factors. If these are truly common, then the factors extracted from one sample should explain the structure of returns for a different sample. Thus sample A factors were used as indexes in a model for sample B, sample B for C and C for A. Table 6 reports the distribution of the absolute values of residual correlations when we used as indexes the factors derived from the maximum-likelihood factor analysis. The average absolute values of the residual correlations decrease as we move from the one-factor model to the eight-factor model. However, there is no longer stochastic dominance as we move from the four- to five-factor model for sample A and from the five- to six-factor model for sample C. This evidence is consistent with the presence of four, or possibly five, statistical factors.

If we compare our prespecified factors to the statistical factors, we see that our five prespecified factors do slightly better than the statistically extracted four-factor solution although the differences are not statistically significant.[13]

[13] The comparison is biased in favor of the statistical model because we fit and test the model in the same time period.

The average absolute value residual correlation from our five-factor prespecified model (base plus MGO) is the same or less than that of the four-factor model from the factor analysis. Furthermore, when we regress each of the four factors from the statistical factor model on the five prespecified factors, the four statistical factors are highly related to our five prespecified factors (see Table 7).[14] In addition, all of the five prespecified factors are significantly related to the statistical factors at the .01 level. Since four statistical factors capture the bulk of the residual covariances between funds, and since our five prespecified indexes perform as well or better, the five prespecified indexes seem to capture all common influences.

In this section we have presented evidence that four factors (or at most five) derived from maximum-likelihood factor analysis seem to capture the covariance between securities. In addition, our five-index fundamental model (base plus MGO) does at least as good a job of explaining covariances as does the four-index factor model. The performance is close, which is not surprising since each of the four factors is highly correlated with the five indexes in our fundamental model. When the base plus growth five-index model is used, the estimate of the residual covariance between securities for most groups is not statistically significantly different from zero. Almost all of the estimated residual covariance between funds comes from common holdings, and assuming that covariances between security

[14] The same results hold if we reverse the process. Each of the five fundamental factors is highly related to the four statistical factors.

residuals from the five- index model are all zero produces better estimates than assuming that they are at their estimated levels.

F. Implications of Common Holdings for Investor Behavior

One of the implications of this paper is that common holdings are an important source of risk for investors. Mutual funds add stocks on the basis of their own analysts' recommendations or upon the recommendations of outside analysts. Internal analysts will be influenced by outside analysts. Thus the recommendations concerning which stocks to purchase have a great deal of commonality across funds. This should lead to stocks being held in common with more common holdings across funds with similar objectives. Investors, believing they are getting diversification by buying a portfolio of mutual funds, will get less than anticipated because of common holdings. Even a very sophisticated investor who examines a fund's loadings on factors (indexes) will get less diversification than expected because of common holdings.

III. CONCLUSION

In this paper we have examined several alternative models of the return-generating process. We have chosen to test the models on mutual fund data because these data lead to a natural differentiation on important influences while damping out random influences and because the indexes uncovered by this research have a natural advantage in measuring mutual fund performance.

The research reveals that:

1. Probably four, but possibly five, statistically extracted factors affect mutual funds.
2. A five-index model based on interpretable and publicly available return indexes does as well as the four-index factor models.
3. While four of the five economic indexes are generally used return indexes, the fifth is an index based on mutual fund data itself.
4. While an important reason the fifth index is included is that it captures the effect of common holdings, the fifth index also introduces an independent influence.
5. When examining mutual fund data, securities held in common represent an important influence.
6. When the effect of common holdings is taken into consideration, a five-index model based on publicly available observable indexes seems sufficient to account for the covariances between funds.

BIBLIOGRAPHY

Berry, Michael, Burmeister, Edwin and McElroy, Marjorie, 1988, "Sorting Out Risks Using Known APT Factors," *Financial Analysis Journal,* 44:2, 29-42.

Blake, Christopher R., Elton, Edwin J., and Gruber, Martin J., 1993, "The Performance of Bond Mutual Funds," *Journal of Business,* 66:3, 371-403.

Brown, S. J., Goetzmann, W., Ibbotson, R., and Ross, S., 1992, "Survivorship Bias in Performance Studies," *Review of Financial Studies,* 5:4, 553-580.

Burmeister, Edwin, Roll, Richard, and Ross, Stephen, 1994, "A Practitioner's Guide to Arbitrage Pricing Theory." In *A Practitioner's Guide to Factor Models,* The Research Foundation of the Institute of Chartered Financial Analysts, Charlottesville, VA, 1-30.

Burmeister, Edwin and McElroy, Marjorie, 1987, "APT and Multifactor Asset Pricing Models with Measured and Unobserved Factors: Theoretical and Econometric Issues," Discussion Paper, Department of Economics, University of Virginia and Duke University.

Burmeister, Edwin and Wall, Kent, 1986, "The Arbitrage Pricing Theory and Macroeconomic Factor Measures," *The Financial Review,* 21:1, 1-20.

Chen, Nai-fu, Roll, Richard and Ross, Stephen, 1986, "Economic Forces and the Stock Market," *Journal of Business,* 59:3, 383-404.

Cho, D. Chinhyung, Elton, Edwin J., and Gruber, Martin J., 1984, "On the Robustness of the Roll and Ross Arbitrage Pricing Theory," *Journal of Financial and Quantitative Analysis,* 19:1, 1-10.

Dhrymes, Pheobus J., Friend, Irwin, and Gultekin, N. Bulent, 1984, "A Critical Reexamination of the Empirical Evidence on the Arbitrage Pricing Theory," *The Journal of Finance,* 39:2, 323-346.

Elton, Edwin J. and Gruber, Martin J, 1994, "Multi-Index Models Using Simultaneous Estimation of All Parameters." In *A Practitioner's Guide to Factor Models,* The Research Foundation of the Institute of Chartered Financial Analysts, Charlottesville, VA, 31-58.

Elton, Edwin J. and Gruber, Martin J., 1992, "Portfolio Analysis With a Non-Normal Multi-Index Return-Generating Process," *Review of Quantitative Finance and Accounting,* 2:1, 5-

17.

Elton, Edwin J., Gruber, Martin J., and Blake, Christopher R., 1996a, "The Persistence of Risk-Adjusted Mutual Fund Performance," *Journal of Business,* 69:2, 133-157.

Elton, Edwin J., Gruber, Martin J., and Blake, Christopher R., 1996b, "Survivorship Bias and Mutual Fund Performance," *Review of Financial Studies*, in press.

Elton, Edwin, Gruber, M., Das, S., and Hlavka, M., 1993, "Efficiency With Costly Information: A Reinterpretation of Evidence for Managed Portfolios," *Review of Financial Studies,* 6:1, 1-22.

Elton, Edwin J., Gruber, Martin J., and Rentzler, Joel, 1983, "The Arbitrage Pricing Model and Returns on Assets Under Uncertain Inflation, *The Journal of Finance,* 38:2, 525-538.

Fama, Eugene, 1993, "Multifactor Portfolio Efficiency and Multifactor Asset Pricing," University of Chicago, working paper.

Fama, Eugene and French, Kenneth, 1993, "Common Risk Factors in the Returns on Bonds and Stocks," *Journal of Financial Economics,* 33 (February), 3-53.

Fama, Eugene and French, Kenneth, 1992, "The Cross Section of Expected Stock Returns," *The Journal of Finance,* 47:2, 427-466.

Jensen, Michael, 1966, "Risk, the Pricing of Capital Assets and the Evaluation of Investment Portfolios," *Journal of Business,* 42:2, 167-247.

Lehmann, Bruce and Modest, David, 1988, "The Empirical Foundations of the Arbitrage Pricing Theory." *Journal of Financial Economics,* 21:2, 213-254.

Roll, R. And Ross, S. A., 1980, "An Empirical Investigation of the Arbitrage Pricing Theory," *Journal of Finance,* 35:5, 1073-1103.

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

TABLE 1

COMPARISON OF ALTERNATIVE RETURN-GENERATING PROCESSES

PANEL A

	Zero-Index Model			S&P One-Index Model			Base Four-Index Model		
Threshold Value	A	B	C	A	B	C	A	B	C
0.010	3916	3916	3916	3818	3827	3812	3720	3705	3707
0.025	3916	3916	3916	3665	3681	3653	3406	3419	3400
0.050	3916	3916	3916	3394	3432	3394	2902	2948	2887
0.100	3916	3916	3916	2872	2983	2908	1996	2034	2075
0.150	3916	3916	3916	2348	2545	2388	1279	1285	1318
0.200	3916	3915	3916	1915	2141	2008	812	765	802
0.250	3916	3909	3916	1528	1748	1630	454	404	455
Average Abs. Val. Correlation	0.814	0.831	0.840	0.228	0.244	0.235	####	0.123	0.126

PANEL B

(alternative five-index models; base model plus index shown)

	Factor			Nat. Resources			Growth		
Threshold Value	A	B	C	A	B	C	A	B	C
0.010	3690	3676	3665	3713	3696	3727	3676	3680	3672
0.025	3339	3302	3292	3389	3405	3424	3300	3293	3333
0.050	2741	2687	2744	2837	2946	2914	2771	2682	2746
0.100	1767	1700	1749	1928	2001	2051	1750	1682	1734
0.150	1052	979	948	1262	1270	1315	1033	967	960
0.200	529	507	475	752	736	777	540	493	488
0.250	261	235	217	435	392	447	262	243	225
Average Abs. Val. Correlation	0.107	0.104	0.103	0.122	0.121	0.126	####	0.103	0.104

PANEL C

(alternative four-index models, using alternative growth minus value indexes)

	Base			Barra			Russell		
Threshold Value	A	B	C	A	B	C	A	B	C
0.010	3720	3705	3707	3707	3744	3732	3703	3732	3713
0.025	3406	3419	3400	3415	3448	3465	3382	3425	3424
0.050	2902	2948	2887	2947	3004	3024	2871	2959	2969
0.100	1996	2034	2075	2110	2150	2219	2037	2059	2132
0.150	1279	1285	1318	1445	1430	1576	1375	1359	1439
0.200	812	765	802	967	915	1054	881	822	907
0.250	454	404	455	606	554	660	533	479	526
Average Abs. Val. Correlation	0.125	0.123	0.126	0.137	0.136	0.144	####	0.128	0.133

Notes: Table shows number of absolute values of pairwise residual correlations greater than threshold values for samples A, B and C (@ 89 funds). Zero-index model uses unadjusted excess returns (over the 30-day T-bill rate) of the sample funds; one-index model uses the excess return on the S&P 500 index; base four-index model uses the excess return of the S&P 500 index, the excess return of a composite bond index, the average of the Pru-Bache small-cap indexes minus the average of the Pru-Bache large-cap indexes, and the average of the Pru-Bache growth indexes minus the average of the Pru-Bache value indexes.

The alternative five-index models use the base four-index model plus an additional index as follows:

"factor" uses a single factor extracted from the residuals of the sample funds' excess returns regressed on the base four-index model, where sample A uses a factor extracted from sample C, sample B uses a factor from sample A, and sample C uses a factor from sample B;

"nat. resources" uses the excess return of an equally weighted portfolio of 38 natural resource stocks from the S&P 500, orthogonalized to the S&P 500 index;

"growth" uses the the residual of the excess return of the Morningstar Growth fund index obtained from the base 4-index model.

The alternative four-index models use alternative growth-value indexes as follows:

"base" uses a growth minus value index obtained from Pru-Bache indexes as described above;

"barra" uses a growth minus value index obtained from BARRA/S&P indexes;

"russell" uses a growth minus value index obtained from Russell 1000 indexes.

TABLE 2

DISTRIBUTION OF BETAS FROM FIVE-INDEX GROWTH MODEL

	from 267 sample funds					from CRSP deciles				
index	XSP500	XAGGHY	PRUSMLG	PRUGRVL	MGO	XSP500	XAGGHY	PRUSMLG	PRUGRVL	MGO
minimum	0.044	-0.380	-0.139	-0.583	-0.317	0.926	-0.095	-0.144	-0.532	-0.232
25th percentile	0.724	0.028	0.120	-0.048	0.270	0.936	-0.001	0.446	-0.176	0.633
median	0.836	0.103	0.231	0.152	0.592	0.961	0.041	0.711	-0.082	0.714
75th percentile	0.906	0.188	0.351	0.406	0.978	0.966	0.078	0.860	-0.048	0.804
maximum	1.106	0.861	0.996	1.598	2.537	0.996	0.143	1.383	0.046	0.961
standard deviation	0.173	0.172	0.201	0.346	0.526	0.022	0.074	0.423	0.170	0.382
interquartile range	0.182	0.160	0.231	0.454	0.708	0.030	0.079	0.414	0.128	0.171

Note: "XSP500" is the excess return (over the 30-day T-bill rate) of the S&P 500; "XAGGHY" is the excess return of a composite bond index; "PRUSMLG" is the average of the Pru-Bache small-cap indexes minus the average of the Pru-Bache large-cap indexes; "PRUGRVL" is the is the average of the Pru-Bache growth indexes minus the average of the Pru-Bache value indexes; "MGO" is the residual of the Morningstar Growth fund index obtained from the base 4-index model.

TABLE 3

DISTRIBUTION OF PERCENTAGES OF COMMON HOLDINGS

Fund Types	proportion with 0%	median %	25th percentile	75th percentile	highest %
AG, AG	8.89%	2.85%	1.88%	5.28%	8.17%
G, G	5.71%	4.57%	3.13%	6.22%	12.02%
I, I	0.57%	5.59%	3.95%	6.73%	11.44%
AG, G	17.71%	2.71%	1.13%	4.53%	10.53%
AG, I	33.03%	1.34%	0.00%	2.99%	6.64%
G, I	4.24%	4.25%	2.89%	5.75%	16.12%

Note: "AG" = aggressive growth funds; "G" = long-term growth funds;
"I" = income, balanced, and growth and income funds.
The percentages shown are obtained from Morningstar composition data for 78 funds in sample A.
For the last four columns, the percentages shown are based on the square root of the sum of the scaled products of the fractions of securities held in common between pairs of funds (i.e., the square root of the last term in equation (3) in the text).

TABLE 4

ESTIMATES OF VARIANCES AND COVARIANCES OF RESIDUALS FOR INDIVIDUAL SECURITIES FROM EQUATION 4

PANEL A
RESIDUALS OBTAINED FROM 4-INDEX BASE MODEL

Fund Types	Covariance (intercept)	t	Slope	t	Estimated Variance
AG, AG	0.6464	3.61	158.78	2.24	159.42
G, G	0.1160	2.76	99.98	8.01	100.10
I, I	0.1343	3.88	11.50	1.29	11.63
AG, G	0.2535	5.22	176.13	8.37	176.38
AG, I	0.1196	3.24	91.37	2.66	91.49
G, I	0.1843	8.18	13.30	1.75	13.48

PANEL B
RESIDUALS OBTAINED FROM 5-INDEX GROWTH MODEL

Fund Types	Covariance (intercept)	t	Slope	t	Estimated Variance
AG, AG	0.3199	2.07	58.26	0.95	58.58
G, G	-0.0614	-1.77	35.43	3.44	35.37
I, I	0.0003	0.01	24.91	3.15	24.91
AG, G	-0.0332	-0.82	79.40	4.49	79.37
AG, I	-0.0991	-3.03	90.36	2.96	90.26
G, I	-0.0322	-1.67	29.34	4.50	29.31

Note: "AG" = aggressive growth funds; "G" = long-term growth funds; "I" = income, balanced, and growth and income funds.

The estimated variance is obtained by adding the intercept to the slope.

TABLE 5

THE EFFECT OF COMMON HOLDINGS

PANEL A
(base model without and with ajustment for common holdings)

Threshold Value	Base	Regression Estimate
0.010	2858	2853
0.025	2614	2589
0.050	2254	2186
0.100	1590	1475
0.150	1076	942
0.200	692	549
0.250	391	288
Average Abs. Val. Correlation	0.130	0.119

PANEL B
(base model plus MGO without and with alternative adjustments for common holdings)

Threshold Value	Growth	Regression Estimate	Zero-Cov Estimate
0.010	2806	2808	2806
0.025	2522	2551	2547
0.050	2133	2140	2120
0.100	1379	1361	1347
0.150	833	822	810
0.200	444	414	399
0.250	218	199	195
Average Abs. Val. Correlation	0.110	0.108	0.107

Note: Table shows number of absolute values of pairwise residual correlations greater than threshold values for 78 funds from sample A

TABLE 6

COMPARISON OF ALTERNATIVE FACTOR MODELS

	1-Factor			2-Factor			3-Factor			4-Factor		
	A	B	C	A	B	C	A	B	C	A	B	C
Threshold Value												
0.010	3784	3757	3747	3697	3719	3699	3685	3685	3688	3651	3674	3675
0.025	3566	3538	3540	3377	3372	3384	3359	3350	3319	3317	3278	3307
0.050	3206	3146	3154	2887	2830	2862	2819	2798	2766	2721	2712	2714
0.100	2454	2416	2419	2013	1860	1988	1917	1821	1827	1765	1672	1744
0.150	1805	1776	1798	1308	1141	1217	1196	1094	1089	993	973	1011
0.200	1297	1232	1271	769	679	676	686	601	568	532	498	504
0.250	902	832	874	416	347	338	362	309	261	256	237	232
Average Abs. Val. Correlation	0.168	0.160	0.162	0.124	0.115	0.117	0.117	0.112	0.110	0.107	0.104	0.105

	5-Factor			6-Factor			7-Factor			8-Factor		
	A	B	C	A	B	C	A	B	C	A	B	C
Threshold Value												
0.010	3666	3628	3640	3680	3623	3632	3645	3604	3595	3625	3626	3600
0.025	3271	3227	3205	3292	3214	3223	3258	3185	3168	3243	3194	3140
0.050	2690	2591	2555	2665	2562	2529	2602	2510	2451	2540	2474	2465
0.100	1650	1491	1511	1602	1434	1506	1512	1362	1384	1431	1292	1353
0.150	904	781	774	809	707	735	767	641	623	697	593	605
0.200	477	356	335	372	323	325	324	254	236	296	234	227
0.250	228	145	144	154	134	128	124	102	79	107	87	76
Average Abs. Val. Correlation	0.102	0.093	0.092	0.096	0.090	0.091	0.092	0.086	0.085	0.089	0.084	0.084

Notes: Table shows number of absolute values of pairwise residual correlations greater than threshold values for samples A, B and C (@ 89 funds). Factors are extracted from excess returns of each sample. The factors are then used as indexes for time series regressions to obtain residual correlations. Sample A uses factors extracted from sample C; sample B uses factors from sample A; sample C uses factors from sample B.

TABLE 7

ADJUSTED R2'S OF FACTORS (FROM FOUR-FACTOR SOLUTION) REGRESSED ON VARIABLES FROM THE BASE MODEL PLUS MGO

factor	sample A	sample B	sample C
1	1.00	1.00	1.00
2	0.89	0.90	0.86
3	0.76	0.59	0.72
4	0.58	0.67	0.11

Note: The factors are obtained from the excess returns of the funds in each sample.