Mutual Fund Risk Measurement and Future Returns

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This study investigates the relationship between mutual fund returns and historical measures of systematic and unsystematic risk over the 19 year period from January 1969 to December 1987. Employing a variation of the Fama and MacBeth methodology, this research finds that beta is not a significant determinant of monthly mutual fund returns in both a linear and quadratic model. On the other hand, the coefficient on residual standard deviation, even after correcting for multicollinearity between beta and residual standard deviation, is found to be a significant determinant of returns.

INTRODUCTION

The relationship between stock returns and systematic risk has been studied extensively in standard tests of the capital asset pricing model (CAPM) using computer-generated portfolios. Early work by Fama and MacBeth (1973) weakly supports the hypothesis that a linear relationship exists between beta and portfolio return and that residual risk is not a significant determinant of portfolio return.[1] Recent work by a number of researchers employing the same methodology as Fama and MacBeth casts considerable doubt on the explanatory power of beta. Tinic and West (1984) find that the relationship between beta and return is significant only in January. Allowing for a quadratic relationship between return and beta, Tinic and West (1986) find significant nonlinearities in the relationship between beta and return. They also find that residual risk is a significant determinant of returns in January. Lakonishok and Shapiro (1987) conclude that neither beta nor residual risk consistently can explain the cross-sectional variation in future returns. Corhay, Hawawini, and Michel (1987) find that the average risk premium on beta is not significantly different from zero in the New York, London, or Brussels exchanges; however, they find the average risk premium on beta is significant, but negative, for the Paris exchange.

This paper examines the relationship between risk and return for mutual funds, rather than computer-generated portfolios. Most mutual fund studies examine the relationship between mutual fund risk and return on a contemporaneous basis, in which the same period is used to estimate risk and return.[2] This paper differs from prior work on mutual funds because it examines the power of historical risk measures to explain future returns.

The examination of the explanatory power of risk estimates for mutual funds is of interest for two reasons. First, it is of value to investors who rely on historical estimates of beta in making investment decisions. Second, it provides additional evidence in support of or against the CAPM.

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[1] In Fama and MacBeth (1973) the t-statistic on the beta coefficient is only 1.73 for 1956 to 1968, the most recent period in their study.

[2] See, for example, Jensen (1968), Friend, Blume, and Crockett (1970), McDonald (1974), and Mains (1977).

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MODEL SPECIFICATION

The total risk of a portfolio, as measured by the variance of the distribution of future returns, commonly is decomposed into systematic and unsystematic components. Systematic risk is measured by the beta of the market model regression, and unsystematic risk is measured by the residual standard deviation of the regression.

If investors are compensated for bearing risk, then risk (if properly measured) should explain, on average, some portion of the cross-sectional variation of the returns on mutual funds. With this in mind, the test is based on the following stochastic model for returns:

$$(1)\ R_{it} = R_{ft} + \gamma_{1t}\beta_i + \gamma_{2t}\beta_i^2 + \gamma_{3t}s_i + \varepsilon_{it},$$

where:

R_{it} = The return on fund i over month t;

R_{ft} = Risk free rate of interest;

β_i = Measure of systematic risk or beta of fund i; and

s_i = Measure of unsystematic or residual risk of fund i.

The risk coefficients (γ_{1t}, γ_{2t}, γ_{3t}) will vary randomly from month to month. If the joint hypothesis that the market model and the CAPM hold is correct, then both $E(\gamma_{2t})$ and $E(\gamma_{3t})$ equal zero, and the $E(\gamma_1)$ equals the expected return on the market index less the risk free rate.

METHODOLOGY

The methodology is similar to Fama and MacBeth (1973). The major difference is the portfolio formation stage is not necessary because the portfolios are mutual funds. For each month from January 1969 to December 1987 the beta and residual risk of each mutual fund are estimated with the market model using data from the preceding 60 months. In order to assess the effect of the choice of a market index on the results, both the CRSP value-weighted and equally weighted indices are used.

The excess return on each mutual fund for each month is regressed on the value of beta and residual risk computed at the end of the preceding month. The test proposed in this article is a predictive test because the explanatory variables are estimated from prior data. From the perspective of an investor, as noted by Lakonishok and Shapiro (1986), a predictive test is more relevant than a contemporaneous test that uses the same period to estimate both risk and the relationship between risk and return. Further, a contemporaneous test overstates the significance of explanatory variables.

The monthly cross-sectional regressions generate a time series of estimated coefficients for each risk measure. The coefficient on each risk measure varies randomly from month to month. If investors are compensated for bearing systematic risk, the average estimated coefficient on beta should be positive in the long run.

DATA

The mutual fund database consists of monthly returns of 80 mutual funds over the 24 year period from January 1964 to December 1987. Monthly returns are computed from end-of-month prices and monthly dividends reported in *Standard & Poor's Over-the-Counter Daily Stock Price Records*. Monthly return data on the equally weighted and value-weighted market indices over the same 24 year period come from the monthly return file of the Center for Research in Security Prices (CRSP) of the University of Chicago.

The initial sample of 80 funds consists of stock mutual funds with a wide range of risk postures. Funds that invested primarily in bonds, options, and foreign investments are not included in the sample. The risk posture was determined by the fund's objective as reported in Weisenberger's *Investment Companies*. McDonald (1974) provides evidence demonstrating consistency between a fund's asserted risk category, as classified by Weisenberger, and market risk. To ensure a wide range of risk postures, funds are selected from each of the following categories reported in Weisenberger's *Investment Companies*: aggressive growth, growth, growth and income, and balanced.

Twenty-four of the initial 80 funds either were eliminated or merged with other funds at some time during the study period. When a fund no longer is reported in *Standard & Poor's Over-the-Counter Daily Stock Price Records*, a new fund is added in order to maintain sample size. The new fund is selected from the same risk category as the deleted fund.

Because survival is not used as a criterion in selecting funds, survival bias is not a problem. On the other hand, the changing composition of the sample could bias the results. The magnitude of this bias is believed to be small for several reasons. First, the results are similar to those of researchers using randomly formed portfolios over roughly the same time period. Second, similar results are obtained over two subperiods, even though the composition of the sample is different in each subperiod.[3]

ESTIMATION OF BETA AND RESIDUAL RISK

The beta and residual risk for a particular mutual fund are estimated in month t by regressing the return of each fund on a market index for the 60 months preceding month t. The beta is the ordinary least squares estimate of the coefficient on the market index, and the residual risk is the square root of the sum of the squared residuals of the regression.

The monthly betas and residual standard deviations are estimated over the period January 1969 to December 1987[4] for each mutual fund for two different market indices: the CRSP value-weighted index and the equally weighted index. In order to determine which index to use in the analysis, the R^2 values for the market model regression with the value-weighted index are compared to the R^2 values for the equally weighted index. Betas estimated from the index with the higher explanatory power should provide a better measure of systematic risk.

Some 18,240 values of R^2 (80 funds multiplied by 228 months) are computed for each index. The frequency distribution of R^2 is given in Table 1 for both the value-

[3] The two subperiods are the ten year period from January 1969 to December 1978 and the nine year period from January 1978 to December 1987.

[4] The first five years of data, from January 1964 to December 1969, are used to estimate the set of betas for the beginning of January 1969.

Table 1—Distribution of R^2 for Market Model Regression With CRSP Value-Weighted and Equally Weighted Market Indices

	Percentage of Total R^2 Values of Range				
Market Index	0.0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0
Value-Weighted	0.00	2.39	8.26	37.43	51.92
Equally Weighted	0.11	3.19	30.75	45.56	20.39

Table 2—Distribution of Beta for all Market Model Regressions With CRSP Value-Weighted Index From January 1969 to December 1987

Percentage of Beta Estimates for Range						
0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0	1.0-1.2	1.2-1.4	1.4-
2.35	4.29	18.00	34.55	28.07	7.60	5.14

weighted and equally weighted index. Each column in Table 1 presents the percentage of total regressions for which the R^2 falls within a given range. In general, the R^2 is higher for market model regressions using the value-weighted index. For example, the percentage of regressions for which the R^2 is greater than .6 is 70.5 percent for the value-weighted index and 43.8 percent for the equally weighted index.[5] This result should be expected because mutual funds tend to hold stocks with high capitalization; consequently, the correlation between mutual fund returns and the market index should be higher for the value-weighted index.

The distribution of beta over all regressions is contained in Table 2 for only the value-weighted index. Each column in Table 2 presents the percentage of all estimated betas that fall within a given range. For example, 28.07 percent of all betas are greater than 1.0 and less than or equal to 1.2. The average beta is .98, slightly less than the population mean of 1. This discrepancy, although small, may be the result of some mutual funds holding a portion of their net asset value in money market instruments.

CROSS-SECTIONAL ANALYSIS

If risk is a determinant of mutual fund return, then the expected value of some of the risk coefficients in equation (1) should be different from zero. If systematic risk is a determinant of return, then $E(\gamma_1)$, $E(\gamma_2)$, or both should be different from zero. Likewise, if unsystematic risk is a determinant, then $E(\gamma_3)$ should be different from zero. These hypotheses are tested by examining the cross-sectional regression of future mutual fund returns on historical risk measures. Three different specifications for the cross-sectional regression are tested: a single factor, two factor, and three factor model:

[5] Stambaugh (1982) concludes that inferences about the capital asset pricing model are insensitive to the choice of a market index. Tinic and West (1986) find that beta estimates based upon a value-weighted index have lower standard errors, on average.

(2) $R_{it} - R_f = \gamma_{0t} + \gamma_{1t}\beta_{i,t-1} + \varepsilon_{it}$

(3) $R_{it} - R_f = \gamma_{0t} + \gamma_{1t}\beta_{i,t-1} + \gamma_{2t}\beta^2_{i,t-1} + \varepsilon_{it}$

(4) $R_{it} - R_f = \gamma_{0t} + \gamma_{1t}\beta_{i,t-1} + \gamma_{2t}\beta^2_{i,t-1} + \gamma_{3t}S_{i,t-1} + \varepsilon_{it}$

For each month t a cross-sectional regression of the form given in equation (1), (2), or (3) is performed. This procedure generates a time series of 228 estimated coefficients (12 months multiplied by 19 years) for each risk factor. Following Fama and MacBeth (1973), the coefficients are averaged and tested for significance with a standard t-statistic.[6] The average value of the estimated coefficient i, $\hat{\gamma}_i$, in month t is given by:

$$\bar{\hat{\gamma}}_i = \frac{1}{n} \sum_{t=1}^{n} \hat{\gamma}_{it},$$

where:

n = Number of months in the sample.

EMPIRICAL RESULTS

The results for the three models are contained in Table 3.[7] For comparison, the results of Tinic and West (1984 and 1986), using randomly formed portfolios over the period January 1969 to December 1982, are presented in Table 4. Table 3 Panel A presents the average of the estimated coefficients on beta for the single factor model. Although the average estimated coefficient on beta is positive, it is not significant at the .1 level. Tinic and West (1984) obtain the same result from January 1969 to December 1982. Corhay, Hawawini, and Michel (1987), who apply the Fama and MacBeth methodology to the United States and three other countries, conclude that the estimated average coefficient on beta is not significantly greater than zero in any country except France, where the average is negative. Lakonishok and Shapiro (1986) state "The economic significance of ... [our] results is that investors appear to have no assurance whatsoever that taking higher risks, as traditionally measured, leads to higher returns, even over relatively long periods of time."

Table 3 Panel B presents the average estimated coefficient on beta and beta squared for the two factor model. The average coefficient on beta is negative and not significant, and the coefficient on beta squared is positive and not significant. The joint hypothesis that both are significantly different from zero also is rejected. Hence, even allowing for a

[6] Because no theory is presented to explain the sign of the risk coefficients, all hypothesis tests are two tailed. In other words, this research tests the null hypothesis H: $E(\gamma_i) = 0$ against the alternative K: $E(\gamma_i) \neq 0$.

[7] The results in the remainder of this paper are based upon estimates of beta and residual risk using the CRSP value-weighted index. The results based upon the CRSP equally weighted index are similar.

Table 3—Average Values of Estimated Coefficients for Three Models January 1969 to December 1987

$$R_{it} - R_f = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\beta_{i,t-1} + \hat{\gamma}_{2t}\beta^2_{i,t-1} + \hat{\gamma}_{3t}S_{i,t-1} + \hat{\varepsilon}_{it}$$

	Average of Estimated Coefficients			
Model	$\bar{\hat{\gamma}}_0$	$\bar{\hat{\gamma}}_1$	$\bar{\hat{\gamma}}_2$	$\bar{\hat{\gamma}}_3$
Panel A Single Factor				
	.0036	.0017		
	(1.91)[a]	(0.45)		
Panel B Two Factor				
	.0065	-.0046	.0029	
	(1.81)[a]	(-0.50)	(0.65)	
Panel C Three Factor				
	.0025	-.0004	-.0008	.1272
	(0.67)	(-0.05)	(-0.15)	(2.82)[c]

[a] t-statistic significant at .1 level
[b] t-statistic significantat .05 level
[a] t-statistic significant at .01 level

Table 4—Tinic and West's Average Estimated Coefficients December 1969 to January 1982

	Average of Estimated Coefficients			
Model	$\bar{\hat{\gamma}}_0$	$\bar{\hat{\gamma}}_1$	$\bar{\hat{\gamma}}_2$	$\bar{\hat{\gamma}}_3$
Panel A Single Factor				
	.0041	.0065		
	(1.42)	(1.33)		
Panel B Three Factor				
	-.0109	.0144	-.0092	.2113
	(-1.22)	(1.05)	(-1.56)	(2.50)

Source: Tinic and West (1984, 1986)

quadratic relationship between return and systematic risk, the null hypothesis that the expected coefficient on systematic risk equals zero cannot be rejected.

Panel C examines the relationship between the mutual fund return and a linear combination of beta, beta squared, and residual risk. Neither the coefficient on beta nor beta squared is significant. On the other hand, the coefficient on residual risk is .1272 and significant at less than the .01 level (t-statistic = 2.82). Tinic and West (1986) also find (Table 4) that the coefficient on residual risk is positive and significant with a t-statistic of 2.50. When they average over only January, however, they find the coefficient is positive and significant with a t-statistic of 3.68; when they average over the rest of the year, excluding January, the coefficient, although still positive, no longer is significant.

EXAMINATION OF SEASONALITY IN THE RISK-RETURN RELATIONSHIP

Recent empirical work by Tinic and West (1986) shows there is a January seasonal in the relationship between average portfolio returns and systematic and unsystematic risk. Corhay, Hawawini, and Michel (1987) also find a seasonal pattern in the United States stock market, as well as in three foreign stock exchanges.

The behavior of the risk coefficient in the three models is examined for a variety of subperiods. The estimated risk coefficients are averaged over January, over the remaining months of the year, and over all months in the sample from 1969 to 1987.

The results are summarized in Table 5. Panel A presents the results for the single factor model. The coefficient on beta is not significantly different from zero in any of the three subperiods. In January, however, the t-statistic is 1.61. Tinic and West (1984) find that the coefficient on beta is only significant in January.

Panel B presents the results for the two factor model. For the month of January the coefficient on beta is negative and significantly different from zero with a t-statistic of -4.80; the coefficient on beta squared is positive and significantly different from zero with a t-statistic of 3.46. For the rest of the year, as well as for all months, neither coefficient is significant.

Panel C presents the results for the three factor model. The coefficients on beta and beta squared show the same pattern as in the two factor model: The coefficient of beta is negative and significant in January, but not significant for the entire year. The coefficient on beta squared is positive and significant in January, but not significant for the entire year. The coefficient on residual risk is positive and significant for the entire year; however, the coefficient is not significant in January, perhaps because the sample consists of only 19 observations. This result is different from the Tinic and West (1986) study in which the coefficient on residual risk is significant only in January.

CORRECTION FOR MULTICOLLINEARITY

The results presented in the preceding section concerning the significance of residual risk could be the result of the correlation between beta and residual standard deviation, as observed by Fama and MacBeth (1973). Analysis of the sample of mutual funds indicates that residual standard deviation and beta are correlated.

A two step procedure is used to correct for multicollinearity. First, the following cross-sectional regression is performed:

$$(5)\ R_{it} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\beta_{i,t-1} + \hat{\gamma}_{2t}\beta^2_{i,t-1} + \hat{\varepsilon}_{it}$$

Table 5—Average Values of Estimated Coefficients for January Versus Rest of the Year From December 1969 to January 1987

		Average of Estimated Coefficients			
Model	Averaged Over	$\bar{\hat{\gamma}}_0$	$\bar{\hat{\gamma}}_1$	$\bar{\hat{\gamma}}_2$	$\bar{\hat{\gamma}}_3$
Panel A Single Factor					
	January	-.0123 (-2.01)[a]	.0320 (1.61)		
	Rest of the Year	.0050 (2.56)[b]	-.0011 (-0.31)		
	All Months	.0036 (1.91)[a]	.0017 (0.45)		
Panel B Two Factor					
	January	.0801 (3.57)[c]	-.1603 (-4.80)[c]	.0920 (3.46)[c]	
	Rest of the Year	-.0002 (-0.06)	.0096 (1.02)	-.0052 (-1.25)	
	All Months	.0065 (1.81)[a]	-.0046 (-0.50)	.0029 (0.66)	
Panel C Three Factor					
	January	.0471 (4.03)[c]	-.1350 (-4.81)[c]	.0847 (3.79)[c]	.5474 (1.37)
	Rest of the Year	-.0016 (-1.10)	.0118 (1.29)	-.0085 (-1.55)	.0890 (2.61)[c]
	All Months	.0025 (1.48)	-.0004 (-0.05)	-.0008 (-.015)	.1272 (2.82)[c]

[a] t-statistic significant at .1 level
[b] t-statistic significant at .05 level
[a] t-statistic significant at .01 level

The residual term of the regression, $\hat{\varepsilon}_i$, is purged of the influence of β_i and β_i^2. The residual $\hat{\varepsilon}_i$ can be thought of as the return on the mutual fund after adjusting for systematic risk. It has two important properties: the sample correlation of $\hat{\varepsilon}_i$ with both β_i and β_i^2 is zero, and the average value of $\hat{\varepsilon}_i$ is zero, as a constant term is included in equation (5).

The second step involves the cross-sectional regression of $\hat{\varepsilon}_i$ on residual risk:

$$\hat{\varepsilon}_i, = \alpha + \gamma_4 s_i + u_i.$$

The coefficient on residual risk is averaged over all months, the months of January, and all months except January. The results, presented in Table 6, show that the coefficient on residual risk is still positive and significant for the entire year at approximately the same level as the three factor model, and, as before, the coefficient is not significant in January. Thus, the significance of the residual standard deviation is not caused by multicollinearity between beta and the residual standard deviation.

CONCLUSION

This study examines the relationship between mutual fund returns and historical measures of systematic and unsystematic risk. Employing a variation of the Fama and MacBeth methodology, this research finds that in a linear model the coefficient on beta is not significantly different from zero; also, in a quadratic model neither the coefficient on beta nor beta squared is significant. On the other hand, the coefficient on residual standard deviation, even after correcting for multicollinearity between beta and residual standard deviation, is significant.[8] The results also verify a January seasonal observed by other researchers in the systematic risk coefficients. The average coefficient on beta and beta squared is significant only in January. Corhay, Hawawini, and Michel (1987) suggest that the January seasonal in the average beta coefficient is the result of the well-known January seasonal.[9]

Table 6—Average Value of Coefficients for Adjusted Model From January 1969 to December 1987

	Average of Estimated Coefficients
Averaged Over	$\bar{\hat{\gamma}}_4$
January	.4105 (1.17)
Rest of the Year	.0566 (2.32)[c]
All Months	.0861 (2.38)[c]

[a] t-statistic significant at .1 level
[b] t-statistic significant at .05 level
[a] t-statistic significant at .01 level

[8] Other researchers have obtained similar results. Roll and Ross (1980) attribute the significance of residual risk to a violation of the assumptions of cross-sectional regression.

[9] They find that in the United States over the period from January 1970 to December 1983 that January is the only month of the year in which the average coefficient on beta and portfolio returns is significantly different from zero.

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