Faculty Working Papers

MUTUAL FUND RATES OF RETURN GENERATING PROCESS:
A GENERALIZED FUNCTIONAL FORM APPROACH

Cheng F. Lee, Professor, Department of Finance
Frank J. Fabozzi, Hofstra University
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College of Commerce and Business Administration
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Summary:

Based upon a generalized rates of return generating process, the correct functional forms of the capital asset pricing model (CAPM) for 85 individual mutual funds are statistically identified. The impacts of the functional form on the estimates of Jensen performance measure, beta coefficient and the unsystematic risk are also explored in detail.

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I. Introduction

Based on the theory of the pricing of capital assets developed by Sharpe [1964], Lintner [1965] and Mossin [1966], Professor Jensen formulated a return generating model to measure portfolio performance [1968]. In a subsequent paper, Professor Jensen [1969] investigated the impact of the investment horizon on the functional form of the model. Lee [1976] has proposed a generalized specification of the model to resolve this problem. Alternative estimation methods for testing the linearity of the model in terms of time series data has also been suggested by Lee. Moreover, the stability of the beta coefficient over time and the impact of the market's condition on both the alpha (or, Jensen's measure of performance [1968]) and beta of the model have come under scrutiny in financial research.[1]

The purpose of this paper is to further investigate the implications of the generalized return generating model developed by Jensen [1969] and Lee [1976] in estimating the parameters of the model for mutual funds. The paper is organized as follows. The second section of the paper defines the generalized return generating model. In the third section, the bias in employing either a linear or logarithmic-linear functional form to estimate the parameters of the model is demonstrated. Alternative estimation methods are employed to estimate the generalized model for a sample of mutual funds in the fourth section. The relationship between heteroscedasticity and the functional form are empirically investigated in section five. Finally, the results are summarized and concluding remarks are indicated in section six.

II. The Generalized Rates of Return Generating Model

Following Lee [1976], the generalized model used to investigate the mutual fund rates of return generating process without error term can be defined as:

$$R_{jt}^* - R_{ft}^* = \alpha_j + \beta_j [R_{mt}^* - R_{ft}^*] \qquad (1)$$

where: $R_{jt}^* = (R_{jt}^{\lambda} - 1)/\lambda$

$R_{ft}^* = (R_{ft}^{\lambda} - 1)/\lambda$

$R_{mt}^* = (R_{mt}^{\lambda} - 1)/\lambda$

λ = the functional form parameter

R_{jt} = 1 + the rate of return for the j-th mutual fund in period t

R_{mt} = 1 + the market rate of return in period t

R_{ft} = 1 + the risk-free rate of interest in period t

β_j = the systematic risk for the j-th mutual fund, and

α_j = the intercept term for the j-th mutual fund.

Equation (1) can be rewritten as:

$$R_{jt}^* = \alpha_j + (1 - \beta_j) R_{ft}^* + \beta_j R_{mt}^* \qquad (2)$$

Equation (2) is a constrained or restricted regression. The relationship is similar to that of Zarembka [1968, pp. 502-504]. Equation (1) reduces to the linear functional form if λ is equal to unity. If the functional form parameter λ approaches zero, then equation (1) reduces to

$$(\log R_{jt} - \log R_{ft}) = \alpha_j + \beta_j (\log R_{mt} - \log R_{ft}) \tag{3}$$

The estimated β_j is Jensen's instantaneous systematic risk and the estimated α_j is Jensen's performance measure in equation (3).

III. Impact of the Functional Form on the Parameters of the Model: Some Analytical Results

Based upon the Taylor expansion, we have

$$e^{\log Y} = 1 + \log Y + \frac{1}{2!} (\log Y)^2 + \frac{1}{3!} (\log Y)^3 + \ldots$$

Equation (1) implies that

$$\frac{Y_t^\lambda - 1}{\lambda} = \frac{1}{\lambda} [1 + \lambda \log Y_t + \frac{1}{2!} (\lambda \log Y_t)^2 + \ldots - 1]$$

$$= \log Y_t + \frac{\lambda}{2!} (\log Y_t)^2 + \frac{\lambda^2}{3!} (\log Y_t)^3 + \ldots \tag{4}$$

where $Y_t = R_{jt}, R_{mt}$ or R_{ft}.

Equation (3) implies that $(Y_t^\lambda - 1)/\lambda$ can be approximated by $\log Y_t$ if the higher order terms are trivial. The conditions for the higher order terms to be trivial are (1) λ approaches zero, and (2) the higher order term of $\log Y_t$ is small. The latter condition depends upon the observation period. If monthly returns are used, then the higher order terms of $\log Y_t$ are generally small. Therefore, the $\hat{\alpha}_j$ and $\hat{\beta}_j$ estimated from

$\log Y_t$ will not be significantly different from those estimated from $(Y_t^{\lambda} - 1)/\lambda$.

Following Zarembka [1968, p. 503], the intercept of equation (1) can be defined as

$$\frac{\alpha_j^{*\lambda} - 1}{\lambda} \quad \text{for some } \alpha_j^* \tag{5}$$

If either λ approaches zero or α_j^* is small, then following equation (4) we can argue that (5) is approximately equal to $\log \alpha_j^*$, where $\log \alpha_j^*$ is the Jensen performance measure for the logarithmic-linear model.

Jensen [1968, p. 394] investigated the impact of the intertemporal instability of beta on the model. Here we shall consider the implication of the functional form on the beta coefficient in terms of an elasticity framework.

In equation (6), the elasticity associated with R_{mt} from equations (1) and (2) is given.

$$\eta R_{mt} = \frac{\partial R_{jt}}{\partial R_{mt}} \left(\frac{R_{mt}}{R_{jt}}\right) = \beta_j \left(\frac{R_{mt}}{R_{jt}}\right)^{\lambda} \tag{6}$$

If λ approaches zero, then the estimated beta is the elasticity between $(\log R_{jt} - \log R_{ft})$ and $(\log R_{mt} - \log R_{ft})$. If λ is significantly different from zero, then the elasticity is a function of R_{mt}, R_{jt} and λ. Since R_{mt}/R_{jt} may vary over time, ηR_{mt} may not be intertemporally stable. If the ratio between the market return, R_{mt}, and return for the j-th fund, R_{jt}, which will be denoted by k, is used to estimate the elasticity ηR_{mt}, then we can analyze the bias associated with ηR_{mt} as follows:

(A) λ is positive

(i) if $k > 1$, then the elasticity obtained from equation (3) underestimates the ηR_{mt}.

(ii) if $k < 1$, then the elasticity obtained from equation (3) overestimates the ηR_{mt}.

(B) λ is negative

(i) if $k > 1$, then the elasticity obtained from equation (3) overestimates the ηR_{mt}.

(ii) if $k < 1$, then the elasticity obtained from equation (3) underestimates the ηR_{mt}.

IV. Empirical Results of Mutual Fund Rates of Return Generating Model

Seventy-three months of data from December 1965 through December 1971 were used to calculate capital gains plus cash dividend monthly returns for a sample of 85 mutual funds. The sample funds consisted of ten large growth funds, twenty-two smaller growth funds, eleven income funds, thirteen balanced funds and thirty diversified common stock funds as classified by Arthur Weisenberger Services. The 85 funds represent about 35% of the funds reported by this service for these five categories. Except for the smaller growth funds, the other four categories constitute at least 37% of the population reported by the service. The Standard & Poor's 500 Composite Average was used to calculate the monthly rate of return (price change plus dividends) for the market. Monthly observations of the 90 day Treasury Bill rate were used as a proxy for the risk-free rate of return.

To determine the functional form parameter, R_{jt}, R_{mt} and R_{ft} were transformed in accordance with equation (1) using λ's between -5 and 5 at intervals of .1.[2] Hence, 101 different regressions were estimated for each fund. For each regression, the logarithmic maximum likelihood value, given by equation (7), was computed. The functional form value that corresponds to the highest value for L max (λ) is then the optimal value, $\hat{\lambda}$.

$$L \max (\lambda) = -n \log \sigma_e(\lambda) + (\lambda - 1) \sum_{t=1}^{n} \log R_{jt} \qquad (7)$$

where n is the sample size and $\sigma_e(\lambda)$ is the estimated regression residual standard error of equation (2). The optimal $\hat{\lambda}$ is shown in column 1 of Table 1 for each fund, while the distribution of $\hat{\lambda}$ is summarized in column 1 of Table 2. The average optimal $\hat{\lambda}$ for the 85 funds was 1.04. Fifty-five funds (65%) exhibited an optimal $\hat{\lambda}$ that was non-negative.

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Insert Tables 1 and 2 here
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Using the likelihood ratio, an approximate 95% confidence region for the optimal $\hat{\lambda}$ for each fund can be obtained from equation (8).

$$L \max (\hat{\lambda}) - L \max (\lambda) < 1/2 \, \chi_1^2 \, (.05) = 1.92 \qquad (8)$$

A 95% confidence interval was computed for each mutual fund and these intervals were used to determine whether the functional relationship is significantly different from one and/or zero. The results are summarized in columns 2 through 5 in Table 2. Nineteen funds (or, 22% of the 85 funds) exhibited a functional relationship that differed significantly from both the linear and logarithmic linear form. For 28 funds (or, 33% of the sampled funds) the hypothesis that the functional form was logarithmic linear was rejected. The linear form was rejected for 25 funds (or, 29% of the total).

The market elasticity calculation based on equations (3) and (2) are presented in the third and fourth columns of Table 1 respectively. The average market elasticity for each fund, $\overline{\eta R}_m$, was computed as follows:

$$\overline{\eta R}_m = (\sum_{t=1}^{73} \eta R_{mt})/73$$

where ηR_{mt} is calculated from equation (6) and represents the market elasticity for the month. If $\overline{\eta R}_m$ is taken as the true market elasticity, then the bias in using $\hat{\beta}_j$ from equation (3) can be measured by

$$(\hat{\beta}_j/\overline{\eta R}_{mt}) - 1 .$$

The absolute value of the bias exceeded 10% for only two funds. The largest bias was 12.8%.[3] Hence, the use of equation (3) as recommended by Jensen [1969] does not result in a serious bias of the average market elasticity. This result was expected for two reasons. First, the previous analytical results derived in the previous section indicate that $\hat{\beta}_j$ from equation (2) should not be significantly different from $\hat{\beta}_j$ estimated from equation (3) if monthly returns are employed. Second, the average ratio of the monthly market return to the funds return, $\overline{k}$, did not vary greatly around unity for each fund.[4]

The Jensen measure of performance, α_j, was not expected to differ materially from equations (2) and (3) when monthly returns are employed [see section III]. The two estimates are shown in the sixth and eighth columns of Table 2, while the corresponding t-values are shown in columns seven and nine.

As noted earlier, the stability of beta is crucial in evaluating investment performance. The fifth column of Table 1 sheds some light on the relative variability, as measured by the coefficient of variation, of the monthly market elasticities, ηR_{mt}. The coefficient of variation exceeded 10% for only one fund. Thus, although the functional form parameter differed significantly from zero for many of the funds, equation (5) indicates that the elasticity will not vary monthly if k is approximately unity in each month. For each fund, the 73 monthly ratios, k, did not depart materially from unity.

One might consider testing for linearity of the model by introducing a quadratic term. This is the procedure employed by Treynor and Mazuy [1966]. The model can be defined without error term as

$$(\log R_{jt} - \log R_{ft}) = \alpha_j + \beta_j(\log R_{mt} - \log R_{ft}) + \gamma_j(\log R_{mt} - \log R_{ft})^2 \qquad (9)$$

The data for the 85 funds was used to fit this regression. It was found that only five (5.8%) of the mutual funds had an estimated γ_j significantly different from zero at the 5% level of significance using a two-tail test. Kamenta [1971] and Lee [1976] have shown that equation (9) is a special case of equation (1). Furthermore, if the absolute value of the parameter λ is larger than one, then equation (9) will be subject to strong specification error. Table 1 indicates that most of the optimal $\hat{\lambda}$'s have an absolute value greater than one. Therefore, the results associated with equation (9) are not as appealing as those associated with equation (2). The Treynor-Mazuy approach for testing for whether fund managers can outguess the market is therefore not sufficiently general to be robust when used empirically; as a result, those results should be carefully re-examined.

V. Functional Form and Heteroscedasticity in the Return Generating Model

The presence of heteroscedasticity for individual U.S. common stock has been examined by Martin and Klemkosky [1975], Brown [1977] and Fabozzi and Francis [1978]. The first study found that heteroscedasticity is not common while the latter two studies found it was. Moreover, Fabozzi and Francis [1978] found heteroscedasticity present in random portfolios. Box and Cox [1964] have shown that heteroscedasticity will affect the functional form parameter. We will investigate empirically the relationship between heteroscedasticity and the functional form of the return generating model in this section.

The Goldfeld-Quandt [1965] test is employed in this study to detect heteroscedasticity. This test is a parametric test requiring (i) ordering the observations by increasing value of one of the explanatory variables which is assumed to be related to the residual variance; (ii) omitting central observations from the arrayed explanatory variable; (iii) computing the residual sum of squares from a least squares regression for the first and last observation groups separately, and; (iv) computing the ratio of S_1/S_2 where S_1 and S_2 are residual sum of squares from the two regressions (the subscript one denotes the larger sum of squares from the two regressions while two represents the smaller). A F-test can then be employed to test for departure from homoscedasticity.

The Goldfeld-Quandt test was used to test for heteroscedasticity in equation (2). The residual variance was assumed to vary with the market return. As suggested by Goldfeld and Quandt, 19 central observations were eliminated. The test was performed for the 85 mutual funds when

(i) λ was assumed to be unity, that is, the linear functional form,

(ii) λ was assumed to be zero, that is, the logarithmic-linear functional form, and

(iii) the correct functional form was used, that is, using the optimal $\hat{\lambda}$ for each fund.

The number of funds that exhibited significant heteroscedasticity at the 5% level of significance were 26, 28 and 15 when the linear, logarithmic linear and generalized forms, respectively, were tested. The detail results of the relationship between the degree of heteroscedasticity and the functional form of eithr market model or capital asset pricing model (CAPM) can be found in the table 3. Note that when the functional form differed from both linear and log-linear forms, six of these 19 funds had heteroscedasticity eliminated by the functional form. Hence, the generalized functional form reduced the problem of heteroscedasticity--but did not eliminate it completely. Approximately 18% of the funds still exhibited heteroscedasticity after the transformation based on the optimal $\hat{\lambda}$.[5]

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Insert Table 3 here

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VI. Concluding Remarks

Based upon Cox and Cox [1964] and Lee [1976], a more general form for mutual fund rates of return generating model was empirically identified for 85 funds during the 73-month period December 1965 to December 1971. A significant number of funds exhibited a functional form which differed significantly from the traditional linear and logarithmic-linear rates of return generating process. Although such a departure results in a specification bias for the systematic risk estimate, it was found that the bias using monthly data was not material for the mutual funds examined.

Hence, when monthly returns are considered, Jensen's performance measure is not materially affected by employing the logarithmic-linear form. Moreover, the results of the general functional form model suggest that the monthly market elasticities of the mutual funds examined were relatively stable. The relationship between the functional form parameter and the residuals of the model was also empirically investigated. Heteroscedasticity was reduced, but not eliminated by using the optimal functional form parameter.

Finally, it should be noted that both the market model and CAPM can be used to predict security returns. Westerfield and Pettit [1974] have found that the prediction power of these models is relatively poor. One of the possible reasons is that the functional form used to forecast the security rates of return is incorrect. This argument is essentially based upon Spitzer's [1978] findings on the relationship between the functional form and the forecasting power of a regression model. Using the data derived from a pseudorandom number generator, Spitzer has shown that a correct functional form will generally improve the forecasting results.

FOOTNOTES

[1]The literature bearing on the intertemporal stability of beta for individual securities, random portfolios and mutual funds is too extensive to enumerate here.

[2]The range was made large enough so that a global maxima would be achieved rather than a local maxima for L max (λ) as defined in equation (7). Equation (2) was estimated instead of equation (1) because of the complexity of the maximum likelihood function for equation (1).

[3]The number of months during the 73-month period that β_j from equation (3) did not differ from the market elasticity for the month, ηR_{mt}, by more than 5% and 10% respectively was computed. For 61 funds, the absolute value of the bias between the elasticity computed from equation (3) and the monthly elasticity from equation (6) was less than or equal to 5% for at least 60 of the 73 months. The absolute bias exceeded 10% for more than 13 months for only four funds.

[4]The value for $\bar{k}$ [$= (\sum_{t=1}^{73} R_{mt}/R_{jt})/73$] for the 85 funds ranged between 0.995 and 1.015. The coefficient of variation of k exceeded 10% for only one fund.

[5]A t-test for sample proportions indicates that the percentage exhibiting significant heteroscedasticity is statistically different from the 5% expected from sampling theory.

TABLE 1

RESULTS OF EQUATIONS (2) AND (3) FOR 85 MUTUAL FUNDS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Fund	Optimal $\hat{\lambda}$	$\hat{\beta}_j$ from equation (2)	$\hat{\beta}_j$ from equation (3)	$\bar{\eta}_{Rm}$	Coef. of variation for η_{Rm}	$\hat{\alpha}_j$ from equation (2)	T-value for 2_j	$\hat{\alpha}_j$ from equation (3)	T-value for 2_j
1	0.000	0.871	0.882	0.870	0.049	0.008	0.266	0.008	0.260
2	-5.000	0.525	0.551	0.541	0.025	0.010	0.874	0.009	0.879
3	0.900	0.619	0.666	0.621	0.063	0.034	0.899	0.034	0.922
4	1.500	0.916	0.914	0.913	0.015	0.006	0.597	0.005	0.527
5	-0.600	1.195	1.239	1.182	0.033	0.042	2.192	0.042	2.236
6	-2.800	0.978	0.992	0.972	0.024	0.016	1.055	0.014	0.930
7	-1.500	1.165	1.181	1.132	0.037	0.034	1.496	0.029	1.321
8	-1.400	1.208	1.246	1.179	0.037	0.048	2.190	0.045	2.083
9	3.000	1.058	1.093	1.066	0.029	0.018	1.019	0.016	0.955
10	5.000	0.954	0.962	0.982	0.031	-0.029	-1.561	-0.028	-1.643
11	-3.600	0.725	0.773	0.765	0.035	-0.008	-0.376	-0.015	-0.793
12	-3.000	0.947	0.941	0.949	0.015	-0.006	-0.682	-0.005	-0.625
13	5.000	1.040	1.047	1.043	0.014	0.001	0.125	0.001	0.080
14	1.300	0.693	0.694	0.692	0.019	0.005	0.520	0.005	0.528
15	2.800	0.970	0.975	0.972	0.015	0.002	0.167	0.004	0.428
16	1.400	1.686	1.805	1.701	0.068	0.076	2.186	0.068	2.026
17	5.000	0.786	0.799	0.797	0.014	0.001	0.160	0.003	0.366
18	0.500	1.306	1.375	1.304	0.036	0.051	2.608	0.051	2.618
19	-1.600	0.908	0.903	0.892	0.018	0.006	0.551	0.005	0.457
20	3.300	0.970	0.989	0.977	0.014	0.008	0.861	0.008	0.963
21	1.200	1.060	1.082	1.062	0.019	0.010	0.811	0.009	0.796
22	5.000	1.106	1.223	1.213	0.112	-0.032	-0.647	0.000	0.001
23	2.300	0.815	0.815	0.822	0.025	-0.008	-0.569	-0.008	-0.573
24	4.300	1.005	1.070	1.028	0.022	0.028	2.183	0.024	1.855
25	4.300	0.845	0.873	0.854	0.019	0.013	1.159	0.016	1.434

TABLE 1 (Continued)

RESULTS OF EQUATIONS (2) AND (3) FOR 85 MUTUAL FUNDS

26	-0.300	1.163	1.179	1.156	0.028	0.016	0.981	0.016	0.970
27	-3.900	0.909	0.918	0.928	0.012	-0.005	-0.663	-0.003	-0.427
28	0.700	1.063	1.085	1.063	0.020	0.015	1.268	0.015	1.276
29	-5.000	0.707	0.707	0.711	0.019	-0.005	-0.480	-0.002	-0.240
30	0.800	0.649	0.684	0.649	0.051	0.021	0.695	0.022	0.720
31	2.100	0.945	1.016	0.976	0.042	0.010	0.390	0.008	0.314
32	-3.600	0.892	0.903	0.890	0.017	0.011	1.043	0.011	1.074
33	-0.200	1.093	1.100	1.086	0.023	0.009	0.602	0.009	0.589
34	-3.900	0.930	0.929	0.922	0.015	0.006	0.659	0.006	0.665
35	-0.500	1.135	1.155	1.144	0.028	0.022	1.332	0.021	1.234
36	-0.700	1.033	1.034	1.035	0.010	-0.001	-0.169	-0.001	-0.193
37	-1.900	1.157	1.183	1.155	0.031	0.023	1.260	0.022	1.173
38	3.900	0.734	0.753	0.743	0.026	0.004	0.273	0.006	0.421
39	5.000	0.985	0.998	0.985	0.023	0.010	0.688	0.012	0.846
40	-0.400	1.246	1.252	1.232	0.039	0.008	0.317	0.007	0.293
41	2.800	0.866	0.853	0.860	0.016	-0.002	-0.234	-0.001	-0.095
42	5.000	0.986	1.008	0.985	0.023	0.018	1.308	0.019	1.491
43	-3.300	0.909	0.924	0.906	0.040	0.016	0.647	0.014	0.598
44	4.000	0.911	0.940	0.914	0.028	0.021	1.221	0.018	1.118
45	2.500	0.902	0.938	0.914	0.019	0.013	1.068	0.013	1.103
46	5.000	0.451	0.477	0.453	0.026	0.021	2.115	0.022	2.241
47	3.600	0.977	0.991	0.978	0.016	0.010	1.057	0.010	1.024
48	5.000	0.952	0.964	0.967	0.019	-0.006	-0.486	-0.003	-0.308
49	-3.000	0.713	0.713	0.709	0.023	0.000	0.005	0.000	0.019
50	1.000	0.626	0.691	0.625	0.054	0.049	1.491	0.051	1.560
51	-4.200	0.090	0.109	0.096	0.038	0.009	1.088	0.009	1.086
52	2.000	1.016	1.028	1.022	0.023	0.002	0.129	0.001	0.037
53	-1.000	1.170	1.182	1.156	0.034	0.016	0.736	0.016	0.755
54	1.800	1.001	1.040	0.994	0.043	0.043	1.684	0.046	1.830
55	1.400	1.052	1.077	1.054	0.040	0.008	0.306	0.007	0.300

TABLE 1 (Continued)

RESULTS OF EQUATIONS (2) AND (3) FOR 85 MUTUAL FUNDS

56	5.000	0.558	0.566	0.561	0.024	0.005	0.455	0.004	0.427
57	1.700	1.171	1.236	1.177	0.033	0.040	2.075	0.041	2.148
58	0.100	1.064	1.060	1.065	0.041	-0.004	-1.460	-0.004	-0.146
59	-0.200	0.899	0.898	0.897	0.029	-0.001	-0.056	-0.001	-0.064
60	-2.800	1.056	1.059	1.018	0.035	0.028	1.268	0.028	1.305
61	1.200	1.437	1.521	1.438	0.047	0.056	2.193	0.056	2.212
62	2.700	1.006	1.008	1.006	0.016	0.002	0.157	0.002	0.197
63	-0.200	1.436	1.475	1.413	0.045	0.039	1.545	0.038	1.521
64	5.000	0.818	0.822	0.821	0.013	0.002	0.280	0.001	0.190
65	2.300	0.809	0.824	0.817	0.013	0.002	0.311	0.002	0.309
66	-1.600	0.954	0.927	0.956	0.028	-0.025	-1.460	-0.025	-1.485
67	4.000	0.980	0.964	0.964	0.021	0.004	0.286	0.006	0.441
68	2.800	0.975	1.057	0.987	0.031	0.052	2.855	0.047	2.636
69	3.900	0.677	0.729	0.706	0.023	0.008	0.647	0.006	0.513
70	2.600	0.719	0.708	0.719	0.019	-0.009	-0.944	-0.007	-0.732
71	-0.500	1.061	1.065	1.059	0.021	0.005	0.354	0.005	-0.374
72	-1.300	0.958	0.974	0.946	0.021	0.020	1.534	0.020	1.541
73	1.900	0.788	0.804	0.789	0.024	0.012	0.833	0.013	0.921
74	2.700	0.742	0.765	0.747	0.021	0.013	1.112	0.014	1.185
75	1.100	0.721	0.716	0.722	0.019	-0.007	-0.724	-0.007	-0.754
76	0.200	0.357	0.368	0.358	0.029	0.008	0.962	0.008	0.963
77	-3.700	1.040	1.041	1.029	0.026	0.010	0.595	0.004	0.253
68	-0.400	1.182	1.203	1.182	0.031	0.021	1.102	0.021	1.104
79	0.700	0.994	1.002	0.996	0.019	0.013	1.112	0.014	1.157
80	4.700	0.979	0.959	0.964	0.015	-0.001	-0.141	-0.003	-0.296
81	4.000	0.888	0.906	0.876	0.025	0.027	1.803	0.031	2.035
82	4.600	1.250	1.388	1.272	0.058	0.084	2.702	0.091	3.403
83	5.000	0.811	0.817	0.807	0.024	0.010	0.703	0.014	0.979
84	3.300	0.745	0.760	0.750	0.019	0.007	0.661	0.008	0.765
85	-3.300	1.128	1.139	1.119	0.025	0.017	1.057	0.011	0.718

TABLE 2

DISTRIBUTION FOR THE FUNCTIONAL FORM PARAMETER $\hat{\lambda}$

	(1)	(2)	(3)	(4)	(5)
Optimal $\hat{\lambda}$	No.	Not different from zero and one	Different from one and zero	Different from zero but not one	Different from one but not zero
= -5	2	0	2	0	0
-4.9 to -4.0	1	1	0	0	0
-3.9 to -3.0	8	1	4	0	3
-2.9 to -2.0	2	0	0	0	2
-1.9 to -1.0	7	6	0	0	1
-0.9 to -0.5	4	4	0	0	0
-0.4 to -0.1	6	6	0	0	0
0	1	1	0	0	0
0.1 to 0.4	2	2	0	0	0
0.5 to 0.9	5	5	0	0	0
1.0 to 1.9	11	11	0	0	0
2.0 to 2.9	11	9	0	2	0
3.0 to 3.9	7	3	1	3	0
4.0 to 4.9	7	2	1	4	0
= 5.0	11	0	11	0	0
Total	85	51	19	9	6

TABLE 3

SUMMARY OF HETEROSCEDASTICITY RESULTS

Functional form results[1]	Heteroscedasticity pattern[2] Assumed value for λ			No. of funds
	λ=1	λ=0	λ=λ*	
λ≠0, λ≠1	0	0	0	6
	1	1	1	7
	1	1	0	6
Total				19
λ=0, λ=1	0	0	0	42
	1	1	1	4
	1	1	0	2
	1	0	1	1
	1	0	0	1
	0	1	0	1
Total				51
λ=1, λ≠0	0	0	0	2
	1	1	1	1
	1	0	0	1
	0	1	0	1
	0	0	1	1
Total				6
λ=0, λ≠1	0	0	0	3
	1	1	1	1
	1	1	0	2
	0	1	0	3
Total				9

[1]Based on functional form test results shown on Table 2.

[2]"0" denotes homoscedasticity and "1" denotes "heteroscedasticity" at the 5% level of significance based on the Goldfeld-Quandt test.

REFERENCES

1. G. E. P. and D. R. Cox, "An Analysis of Transformation," Journal of the Royal Statistical Society, Series B (1964), pp. 211-243.

2. S. B. Brown, "Heteroscedasticity in the Market Model: Comment," Journal of Business (January 1977), pp. 80-83.

3. F. J. Fabozzi and J. C. Francis, "A Note About Heteroscedasticity in the Single Index Market Model," (December 1978). Forthcoming in the Journal of Economics and Business.

4. S. M. Goldfeld and R. E. Quandt, "Some Tests for Heteroscedasticity," Journal of the American Statistical Association (1965), pp. 539-547.

5. M. C. Jensen, "The Performance of Mutual Funds in the Period 1945-64," Journal of Finance (May 1968), pp. 389-416.

6. M. C. Jensen, "Risk, the Pricing of Capital Assets, and the Evaluation of Investment Portfolio," Journal of Business (April 1969), pp. 167-247.

7. J. Kamenta, Elements of Econometrics (New York: The Macmillan Company, 1971).

8. C. F. Lee, "Investment Horizon and the Functional Form of the Capital Asset Pricing Model," Review of Economics and Statistics (August, 1976), pp. 356-363.

9. J. Lintner, "Security Prices, Risk, and Maximal Gains from Diversification," Journal of Finance (December 1965), pp. 587-616.

10. J. D. Martin and R. C. Klemkosky, "Some Evidence of Heteroscedasticity in the Market Model," Journal of Business (January 1975), pp. 81-86.

11. J. Mossin, "Equilibrium in a Capital Asset Market," Econometrica (October 1966).

12. W. F. Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk," Journal of Finance (September 1964), pp. 425-442.

13. J. J. Spitzer, "A Monte Carlo Investigation of the Box-Cox Transformation in Small Samples," Journal of American Statistical Association (1978), 73, pp. 488-493.

14. J. L. Treynor and K. K. Mazuy, "Can Mutual Funds Outguess the Market?," Harvard Business Review (July-August 1966), pp. 131-136.

15. R. Westerfield and R. R. Pettit, "Using the Capital Asset Pricing Model and the Market Model to Predict Security Returns," Journal of Financial and Quantitative Analysis (1974), 9, pp. 579-593.

16. P. Zarembka, "Functional Form in the Demand for Money," Journal of the American Statistical Association (June 1968), pp. 505-511.