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THE DETERMINANTS OF SYSTEMATIC RISK AND THE COST OF CAPITAL FOR THE REGULATED ELECTRIC UTILITY INDUSTRY*

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1.0 Introduction

In the U.S. most electric utility companies are regulated by state commissions which have the legal power to set allowed rates of return on the firm's undepreciated capital base. The process of rate of return regulation has numerous problems inherent to it, not the least of which is the ascertainment of the opportunity cost of capital or that rate which investors expect to earn on a security subject to risk. In fact it generally is true that the overriding issue in the majority of rate cases before regulatory commissions turns on the determination of the cost of capital. In the context of a rate hearing a number of witnesses for the firm, for the commission, and perhaps for other interested parties will present testimony as to the appropriate rate of return for the utility. Often the justification for these recommended rates is based on such simple notions as that the equity rate should be higher than the rates prevailing on corporate debt or that other firms' rates of return should be used as a basis for judging a given firm's required rate of return. In some regulatory cases more analytically rigorous methods will be used to estimate the firm's rate of return. Yet, despite several years of rather intense theoretical work on the pricing of capital assets, regulatory practice has lagged far behind in applying the tools of finance theory to the determination of a fair rate of return. This gap between theory and practice is not entirely unwarranted in view of the fact that equity rates of return are extremely difficult to predict as they depend on numerous uncertain future cash flows, overall market conditions, and investors' expectations.

This paper applies the well-developed Capital Asset Pricing Model (CAPM) to the problem of determining the opportunity cost of capital for the electric utility industry. The matter of explaining and forecasting the cost of capital is approached somewhat indirectly by first considering the determinants of the parameter β, the systematic risk coefficient in the CAPM. These determinants or exogenous variables which describe the financial and regulatory environments within which the firm operates are then used to generate estimates of the cost of equity capital. The paper is organized as follows. First the theoretical structure of the CAPM is discussed. Then a background section briefly describes the process of rate of return regulation, and several prior studies of the determinants of β are noted. Second, a single equation model based on the CAPM is specified and tested. Regression results and forecasts are reported for a sample of sixty-two electric utility firms. A third and concluding section discusses the implications of the findings for rate of return regulation.

In general this paper is considerably different from a number of previous papers which have focused on a narrow set of financial determinants of the cost of capital. Rather, the attempt here is to consider both financial effects as well as those aspects of industry structure and regulatory policy which condition the performance of the electric utility industry.

1.1 The Capital Asset Pricing Model (CAPM).

The work of Sharpe, Lintner, and Mossin[1] has developed a theoretical model of capital market equilibrium under conditions of risk. Their basic result is that given a certain set of assumptions the equilibrium expected return, $E(R_i)$, on any asset i will be linearly related to the returns on the market portfolio,

$$E(\tilde{R}_i) = R_F + \beta_i \, [E(\tilde{R}_m) - R_F] \tag{1}$$

or

$$E(\tilde{R}_i) - R_F = \beta_i [E(\tilde{R}_m) - R_F] \tag{1a}$$

where

$\tilde{R}_i$ = rate of return on security i,

R_F = risk free rate of interest,

$\tilde{R}_m$ = rate of return on market portfolio,

$\beta_i = \sigma(\tilde{R}_i, \tilde{R}_m)/\sigma^2(\tilde{R}_m) = Cov(\tilde{R}_i, \tilde{R}_m)/Var(\tilde{R}_m)$.

The tildes denote random variables. β_i is a measure of the systematic or non-diversifiable risk of security i. β, which is sometimes referred to as a volatility index, provides a direct means for estimating the required return on an individual asset. Equation (1) demonstrates that the appropriate measure of risk for any security is its covariance with the market portfolio and not its own variance. Thus, a firm with a β equal to unity would have a cost of equity capital equal to the expected rate of return on the market. Similarly, a firm with a β greater (less) than 1.0 would have an expected rate of return greater (less) than $E(\tilde{R}_m)$. These relationships illustrate a fundamental axiom of finance theory that assets of equivalent risk should have the same return

and that an asset with greater risk should reward investors with a higher expected return. Finally, it should be noted that the total risk of any given security is composed of both systematic and unsystematic components. In the CAPM framework, it is only the systematic risk which concerns investors and therefore determines the opportunity cost of capital. Unsystematic risk can be diversified away by investors holding efficient portfolios.

1.2 The Structure and Performance of the Electric Utility Industry and The Process of Rate of Return Regulation.

Until recently it had been the conventional wisdom that electric utilities were the prime example of a decreasing cost industry. Given these economies of scale it was thought to be in the public interest to limit the number of suppliers in a given geographic region and thereby exploit the increasing returns to scale. At the same time protection of the public from a monopolist called for the ability to constrain the rate of return earned by a public utility. For these reasons the traditional form taken by public utility regulation has been characterized by control of entry, price fixing, and an obligation to serve all applicants under reasonable conditions.

The majority of electric power produced in the U.S. is from the privately- or investor-owned utilities. It is these firms that will be the subject of this study. During the early and mid-1970's the industry was faced with a number of exogenous shocks that severely impaired it's financial position. This situation is described in Figure 1 which shows mean annual market rates of return, $\bar{R}_t$, earned by sixty-two electric utilities for the period 1958-1975.

$\bar{R}$ is determined by

$$R_{i,t+1} = [(P_{i,t+1} - P_{i,t}) + D_{i,t+1}]/P_{i,t} \quad (2)$$

$$\bar{R}_{i,t} = \prod_{t=1}^{12} (R_{i,t}) \quad (2a)$$

$$\bar{R}_{t} = \sum_{i=1}^{62} (\bar{R}_{i,t})/62 \quad (2b)$$

where

$R_{i,t}$ = monthly market return for firm i in period t,

$P_{i,t}$ = monthly stock price for firm i in period t,

$D_{i,t}$ = monthly dividends for firm i in period t, and the bars denote annualized means.

The overall mean for the entire period was 9.07%, but it is clear that the rate of return has been declining nearly consistently since the late 1960's. Returns in 1975 have shown a marked increase, but it must be considered in light of the base period returns of 1974 which were some of the lowest on record. Over this same period, other indicators of market performance have shown similar patterns.[2] Prices of electricity declined over most of the 1960's, but since 1970 have risen steadily with an extraordinarily large increase occurring in 1974. These price increases obviously have not improved profitability because costs have been increasing at a more rapid rate. Most observers believe that the primary causes of this poor performance by the industry are:

1. sharply rising rates of inflation;
2. large increases in the cost of factor inputs,
3. concern over the environment, and most notably
4. the actual process of rate of return regulation.

Let us now consider this last matter in more detail.

There are three procedural elements to the process of rate of return regulation. First, commissions must certify the admissibility of certain operating costs and capital expenditures. Second, the size of the rate base must be determined. Third, a fair rate of return must be set. These elements are best viewed in terms of a standard regulatory costing formula used by the Federal Power Commission to set prices on interstate sales for resale of natural gas[3]

$$RE = P_g + C_0 + \{d_T + r(1+x)[\sum_{t=1}^{T} (k_t - d_t)]\}/v \qquad (3)$$

where

RE = required earnings per unit,

P_g = average field price of all gas purchased,

C_0 = unit costs of operation,

d_T = depreciation expense in current year T,

r = average rate of return on the rate base,

x = rate of tax on income ,

$\Sigma(k_t - d_t)$ = rate base or undepreciated cost of equipment,

k_t = capital at purchase price for year t,

v = vȯlume of gas.

Thus, the cost of service is defined as the total of gas purchase costs, operating and maintenance expenses, taxes, current depreciation of capital investment, and an "acceptable" rate of return on the undepreciated portion of that investment.

Because current depreciation, d_T, directly enters the allowed revenue formula, utilities might find it in their interest to accelerate the rate of depreciation

in order to recover more quickly their investment costs and thereby finance a more rapid rate of growth. In most cases electric utilities are required to use either the flow through or normalized depreciation method, both of which are means of accelerating depreciation for tax purposes. Some regulatory commissions allow as expense an hypothetical tax bill that the utility would have paid had it not elected to accelerate its depreciation.[4] These commissions have required the establishment of a reserve, called a normalization reserve, equal to the difference between taxes paid and taxes allowed as an expense. This reserve is then used to pay the taxes that will ultimately come due. Other commissions do not allow firms to recognize the deferred tax liability, but rather require the effect of liberalized depreciation to be flowed through to current income. Also the flow through firm must offset their income increase by simultaneously reducing utility service rates.

In perfect markets it would be difficult to argue that a firm's accounting practices could affect its cost of capital. However, given certain market imperfections, it is possible to show that firms on a flow through basis have an implicit debt not shared by normalizing firms, i.e. the burden of future debt is not funded. Therefore, it is argued, flow through accounting increases a firm's systematic risk.[5]

Another cost-related regulatory policy which affects utilities' systematic risk is the treatment of interest charges during construction. Typically a firm will undertake a construction project over the course of several years, and often such projects will be financed almost entirely by debt issues. Rather than treating interest payments as a cost of operation to be reimbursed through equation (3), commissions have required that interest during construction enter the firm's

books as a revenue item! This has the effect of restricting the amount of revenues a firm can earn given its regulatory constraint. Once the construction project is completed the asset enters the firm's rate base on which the firm can earn a rate of return, but in the short run this odd accounting treatment and reimbursement schedule can lead to severe cash flow problems. All other things equal, an increase in a firm's interest charges during construction should lead to an increase in the firm's β.

From equation (3), the firm's rate base is defined by $\sum_{t=1}^{T} (k_t - d_t)$, or the difference between total usable capital and the accumulated depreciation on these same capital assets. The proper method for asset valuation has been argued over in numerous public utility rate cases. In general most state commissions follow either a "fair value" or "original cost" standard. Where the former method is intended to approximate, but not necessarily equal, the replacement cost of the firm's assets, and the latter simply requires that a firm figure its rate base in terms of the book value of its assets at their purchase cost. Because the size of the rate base directly affects the amount of revenues that a firm is allowed to earn, one might expect that fair value firms would be permitted to charge relatively higher prices under otherwise identical conditions. Thus if regulators allowed investors to earn the opportunity cost of capital on a rate base larger than their actual investment, investors would receive a windfall gain.[6] Aware of this potential, investors might expect regulators to discount somewhat the allowed rate of return in fair value jurisdictions, thereby lowering investors' expectations of future earned rates of return. All of this is to say that one would expect that fair value utilities would have lower betas than original cost firms, <u>ceteris paribus</u>.

As we have noted above, perhaps the single most difficult analytic task facing the regulatory commission is the determination of a "fair rate of return." This return, r in equation (3), is generally computed as a weighted average of the debt and equity costs of the particular firm. The formula most often employed in rate hearings is

$$r = i(D/V) + R(E/V) \tag{4}$$

where

r = the overall or weighted cost of capital,

i = the "embedded" or average cost of debt,

D = book value of the firm's outstanding debt,

R = the cost of equity capital,

E = book value of the firm's equity, and

V = D + E.

Aside from the fact that such a formula has a number of problems associated with its use, it clearly illustrates that R is the only variable which the regulators cannot directly observe. That is, D and E are book weights and i is simply the firm's total interest payments divided by D; thus all of these variables can be obtained from the firm's accounting statements. (This is not to say that there might not be some contention over these data in the regulatory hearing).

Arriving at a value for R is more problemmatic because in theory this is the rate of return that investors expect to earn when they purchase an asset subject to a degree of risk. In practice, commissions will often hear testimony

based on several different methods for estimating R before rendering their final judgement. The most common means for estimating investors' opportunity costs are:[7]

1. Current interest rates on corporate debt provide a lower bound on the cost of equity capital.

2. Historical averages of earned rates of return, preferably market rates as opposed to book, indicate the relative level and trend in R.

3. Given a no growth firm or some means for evaluating the rate at which a firm will grow that has opportunities to invest at greater than its cost of capital, then the firm's earnings-price ratio can be used to estimate R, as in $R = EPS_1/P_0 + PVGO$ (5)

   where
   EPS_1 = earnings per share in period 1,
   P_0 = price per share in period 0, and
   PVGO = present value of future growth opportunities.

4. The discounted cash flow (DCF) method is often used to estimate R, according to $R = D_1/P_0 + g$ (6)

   where D_1 = dividends per share paid in period 1, and
   g = rate of growth in dividends.

For firms with a fairly constant rate of growth in earnings and dividends, the DCF apparatus is a fairly reliable method for developing an estimate of R.

Although rarely introduced as evidence in a formal regulatory hearing, it should be clear that the CAPM can be viewed simply as another method for estimating the firm's cost of equity capital. The value of $\tilde{R}_i$ on the left hand side of equation (1) is a probabilisitc representation of the expected or required rate of return, R, as it appears in equations (4) - (6).

Another factor which is causally linked to a firms β is the notion of the stringency of rate regulation or the gap between the allowed rate of return, let us call it S and assume there is no debt, and the required rate of return on equity, R. One way of approximating the difference, S-R, is to compare a firm's market value (i.e. stock price times number of shares outstanding) with its book value or asset size. If S > R then the firm's market value must increase relative to book value, otherwise the firm's shares would offer a higher rate of return than other firms' of comparable risk and the capital market would be in disequilibrium.[8] Conversely, market value will be less than book value in cases where S < R. Only when the firm consistently earns a rate of return equal to its cost of capital would one expect market value to equal book value. In general, β should increase as S is greater than R. At first it might seem counterintuitive that a firm should become more risky as the regulatory constraint were loosened, but the point becomes clearer if one considers that an unconstrained monopolist would be able to earn maximum profit and thereby be subject to more systematic risk in terms of the covariability between its own returns and returns on the market.[9] In other words, a tightening of the regulatory constraint may reduce firms' profits from levels they might otherwise attain, but the tightness of the constraint does serve to make the utility "safer" in terms of the CAPM.

Additional aspects of the regulatory environment are the extent of changes in the utilities' factor input prices and the measures taken by commissions to deal with these changes. In the recent years of double digit inflation many commissions built an inflation premium into their allowed rates so that the firm was not required to return immediately to the regulator for an increase in its rates. Automatic fuel adjustment clauses and future test year cost data are also procedural measures that have been invoked to cushion the effect of inflation on the regulated firm. For many of the same reasons mentioned above with respect to the market-book ratio, one would expect the regulated utility's β to vary indirectly with the rate of change in the price level. In times of rising inflation of costs, firms without rate relief in the form of a rate increase resulting from a commission decision or some cost pass-through mechanism will find it increasingly difficult to earn S. Thus regulatory lag during highly inflationary periods will cause a decrease in the firm's volatility index because the firm will not be able to pass along to its customers the full effect of inflation.

One final dimension of the regulatory environment which determines a firm's β is the effect that a rate hearing can have on investors' expectations of required rates of return. In most instances, firms seek a rate increase when

the current structure of their prices no longer covers costs. It has been noted that during periods of rising average costs, more and more firms will petition their regulatory agency in order to raise their prices.[10] One must presume that firms that are seeking a rate hike are finding it increasingly difficult to earn the rate of return which they are allowed. According to this view, a firm's systematic risk should increase once some part or all of its rate request has been granted. Investors expect that a favorable outcome from the rate hearing will permit the firm to earn at least its allowed rate of return. Thus a simple dummy variable for the year in which a commission decision is rendered should have a positive effect on β.

1.3 Previous Work on the Financial Determinants of Systematic Risk

There have been a large number of previous empirical analyses of the financial factors affecting a firm's β. To date, only Myers and Turnbull[11] have taken a detailed approach to the theoretical aspects of the problem. Briefly, their results indicate that β depends in a complicated way on several factors, including: 1.) a series of indexes which generate the firm's cash flows, 2.) asset life, and 3.) the growth trend of expected cash flows. It is shown that β will vary indirectly both as a function of the life of a firm's assets and of the present value of future growth opportunities. These hypotheses remain as yet untested.

On the empirical side, perhaps the best known studies of risk determination are those by Beaver, Kettler, and Scholes,[12] and Rosenberg and McKibbin.[13] Also work by Melchier,[14] Robichek, Higgins, and Kinsman,[15] and Litzenberger and Rao[16] have focused specifically on this issue as well as the estimation of the cost of capital within the context of the electric

utility industry. The fundamental concept behind much of this material is that a majority of the information imparted by accounting data is impounded in the market price of the stock. Accepting this as true, then one should find that accounting measures of risk will explain variations in β. The most often used variables for testing this relationship have been 1) leverage, 2) size, 3) growth, and 4) earnings variability. In many cases the theoretical justification for the inclusion of these variables and numerous additional measures has been weak, however let us quickly review some arguments in support of the more plausible financial determinants of β.

First, theory supports the view that increasing amounts of debt will increase the riskiness of the firms. Basically the probability of default increases as more debt enters the firm's capital structure, thus systematic risk increases proportionately with leverage. Second, many observers believe that large firms are somehow "safer" than small firms. However, the link between size and systematic risk is not a well understood one. To the extent that large firms have longer-lived assets than small firms then the Myers-Turnbull hypothesis might explain the conventional wisdom that size and β should be inversely related. Third, most empirical studies associate high growth firms with more risk than stable or low growth firms. However, a firm can grow for a number of reasons, e.g. low payout ratios, opportunities to earn greater than R, etc., and it is not at all clear what interrelationship these different factors can have with one another. Fourth, again the received view suggests that firms with highly variable earnings will have higher risks than firms with stable earnings. Although theoretically investors do not strictly care about the variance in a firms' earnings, there is empirical support for a positive association between β and earnings variability.

2.1 Model Specification.

In Section 1.2, the Capital Asset Pricing Model (CAPM) was introduced as a general theoretical tool for explaining capital market equilibrium under conditions of risk. For convenience equation (1) is repeated:

$$E(\tilde{R}_i) = R_F + \beta_i[E(\tilde{R}_m)-R_F] \tag{1}$$

It will be recalled that the parameter β measures the systematic or non-diversifiable risk of security i in terms of the normalized covariance between returns on security i and returns on the market portfolio. In the theory underlying equation (1) it is assumed that β is constant over time, but a legion of critics have pointed to the inapplicability of this assumption. It is proposed here that β is a function of firm specific and regulatory variables which vary over time and induce changes in β over time.

Suppose there is a linear relationship between β and these independent variables, call them Z's, describing the firm's environment. Then a simplified model of the determinants of β would be

$$\beta_{i,t} = \alpha_0 + \alpha_j Z_{i,j,t} + \varepsilon_{i,t} \tag{7}$$

where the k α's are parameters to be estimated, t indexes time, and the error, ε, conforms to the usual Gauss-Markov assumptions. However, equation (7) would be difficult to estimate empirically because $\beta_{i,t}$ cannot actually be observed and must also be estimated via equation (1). If equation (7) was used to explain $\hat{\beta}_{i,t}$ then one might simply be trying to fit the measurement error around the true value of β. A more direct procedure for testing the determinants of β would be to rewrite (1) to include time:

$$R_{i,t} = R_{F,t} + \beta_{i,t}[R_{m,t}-R_{F,t}] + \mu_{i,t} \tag{8}$$

where μ is a random error term, and then by substituting (7) into (8) and rearranging, one obtains

$$R_{i,t}-R_{F,t} = \alpha_0 R_{mF,t} + \alpha_j Z_{i,j,t} R_{mF,t} + \varepsilon_{i,t} R_{mF,t} + \mu_{i,t} \qquad (9)$$

or

$$R_{i,t}-R_{F,t} = \alpha_0 R_{mF,t} + \alpha_j Z_{i,j,t} R_{mF,t} + \eta_{i,t} \qquad (9a)$$

where

$R_{mF,t} = [R_{m,t}-R_{F,t}]$, and

$\eta_{i,t} = \varepsilon_{i,t} R_{mF,t} + \mu_{i,t}$.

Equation (9) could then be estimated over a time series cross section of data to test hypotheses about the determinants of β and in turn to forecast values of the cost of equity capital for the electric utility industry.

Given the composition of the error, $\eta_{i,t}$, in (9a) and the nature of the nonlinearity in the exogenous variables one would expect to encounter a problem with errors in variables in that the independent variables will be correlated with the error term. To correct this a set of instruments, formed from the original $Z_{i,j,t}$'s, can be constructed which are correlated with the right-hand side variables but are orthogonal to $\eta_{i,t}$. Accordingly, all of the regression results which follow have been estimated by the instrumental variables technique (IV), thereby assuring consistent estimates of the α_j's in (9).

Another problem to be dealt with is a possible nonconstant variance for $\eta_{i,t}$ over the cross section of firms. Several prior studies of this general type have noted that large firms seem to have systematically different error variances from small firms. If such is the case then IV estimation will yield inefficient parameter estimates. One simple, but nonetheless sound, procedure

for correcting heteroscedesticity is to select an independent variable, in this case we use asset size, which is known to be correlated with the error variance. Then the regression equation can be transformed by using the size variable to eliminate the nonconstancy in the variance of $\eta_{i,t}$. The results of such a correction procedure are also reported below.

2.2 Data.

A data problem presents itself in trying to estimate equation (9). Ex ante rates of return, the $R_{i,t}$, cannot be observed so ex post or earned rates must be used as proxies. The severity of this problem is not known. All individual company returns data have been calculated from the CRSP monthly returns file. Firm accounting data have been obtained from the COMPUSTAT tape. Some of the regulatory data has come from various public and private sources. All variables and data sources as well as the names of the firms included in the sample are listed in the appendix.

2.3 Expected signs.

Based on the discussion of Sections 1.2 and 1.3, we have developed a number of hypotheses concerning the determinants of a regulated electric utility's systematic risk coefficient. These hypotheses will be tested with equation (9) over a sample of sixty-two firms for the period 1958-1973. Also, a series of simulations and forecasts of the $R_{i,t}$ are also developed which examine the validity of (9) as a model of the process generating returns in this industry. The a priori expectation is that the coefficients of the exogenous variables would enter equation (9) with the following signs:

Regulatory Environment Variables

FLOW: Positive - dummy variable denoting flow through versus normalized depreciation practice.

ICONST: Positive - amount of interest charges during construction.

FAIR: Negative - dummy variable denoting fair value versus original cost rate base jurisdictions.

CPICH: Negative - relative change in the consumer price index.

MVBV: Positive - ratio of market value to book value.

DECDUM: Positive - dummy variable denoting that a rate case was decided.

Financial Environment Variables

LGSZE: Negative - log of asset size.

EVAR: Positive - variability in earnings.

LEVER: Positive - percentage of debt in capital structure.

AGROW: Positive - rate of growth in asset size.

3.1 Results.

Equation (9) was estimated over a pooled time series cross section of data for a variety of different time periods between 1958 and 1971 and for the 62 firm sample. As noted above all results have been obtained by use of instrumental variables where the instruments were the regulatory and financial variables included in that particular regression. R_{mF} was not included as an instrument.

The initial results are shown in Table 1. In general, the signs of the estimated coefficients are as expected. The size variable, LGAST, and market-book ratio, MVBV, are statistically significant from zero in every case and have the predicted sign. AGROW and FLOW take the correct signs but have relatively high standard errors. Both EVAR and LEVER have the wrong signs but only the former shows any statistical significance. Three regulatory variables, ICONST, DECDUM and FAIR, exhibit moderate statistical significance since in about half the cases their coefficient is statistically different from zero at the .05 level. The price level variable, CPICH, is the most problematic in that it is consistently statistically significant at better than the .01 level, but takes the incorrect sign in two out of six cases. This may be due to the fact that the change in the rate of inflation may have a different impact on β depending on whether the change is large or small, positive or negative. Small increases may have drastically different effects on β than large increases. This conjecture is only tentative at present but may explain why one obtains slightly ambiguous results for this coefficient. Overall the fit of the equations is acceptable, however the standard errors of the regression are somewhat large with respect to the means of left hand

side variables. The generally inconclusive and weak statistical significance of several of the accounting variables is not unexpected in light of the problems of previous studies. As a group the regulation-related variables seem to explain a greater proportion of the variance in the ex post rates of return. The fact that regulatory policy can have a significant effect on a firm's systematic risk is perhaps the most interesting and unique result demonstrated in Table 1.

It was noted earlier that the error variances of the estimating equation might be proportional to the size of firm. To test this hypothesis the third equation in Table 2 was estimated with IV, and then the residuals, RES, from the regression were saved. Since the expected value of RES is approximately zero, the variance of RES can be computed by simply squaring the residuals. This was done and the following regression was run with ordinary least squares,

$$\log(RES^2) = \alpha_0 * \log(ASSETS) \tag{10}$$

The results were such that α_0 was different from zero at better than the .01 level. This suggested that the error variance was indeed heteroscedastic and proportional to the size of firm. To correct this problem every variable in Equation (9) was transformed by dividing it by LGAST. The new estimating equation now becomes

$$(R_{i,t}-R_{F,t})/LGAST_{i,t} = \alpha_0(R_{mF,t}/LGAST_{i,t})+\alpha_j[(Z_{i,j,t}R_{mF,t})/LGAST_{i,t}]+ \mu_{i,t}/LGAST_{i,t} \tag{11}$$

One can show that under reasonable conditions the error in (11) is approximately homoscedastic.

Table 2 shows the results of correcting for heteroscedasticity. The first and third equations were estimated with IV, but without any transformation of the data. The results are consistent with those obtained in Table 1. The second and fourth equations in Table 2 were estimated with IV, and the data were transformed as in Equation (11). The difference between the raw and transformed equations is not striking on inspection, but it appears that generally the estimated coefficients are slightly lower for the transformed regressions without there being an associated change in the standard errors of the coefficients. In both cases the proportion of variance explained is greater for the transformed regression. The standard errors of the regression are quite different, but this is to be expected because the unit of measurement is changed by the transformation. In short, the transformation procedure slightly improves the fit but does not substantially alter the pattern of signs nor the statistical significance of the estimated coefficients.

In addition, two final regression results are shown as 5) and 6) in Table 2. For these equations the sample period was extended to 1971 to examine whether the added years of data improved the fit. Both regressions 5) and 6) in Table 2 were estimated by IV without the heteroscedastic correction. The basic results obtained in the previous regressions are again achieved, and with one notable improvement as well. Increasing the sample size changes the sign on the coefficient of EVAR so that it now conforms with the *a priori* expectation.

3.2 Model Validation

In order to test the validity of equations (9) and (11) as models of the process determining systematic risk and required rates of return a series of simulation and forecasting experiments was undertaken. Historical simultions and *expost* forecasts were performed in one step, and then an *ex ante* forecast

was generated based on best estimates of the values of the exogenous variables. Before considering these results two points should be made clear. First, although we have been analyzing the determinants of β this is not the central matter of concern. The systematic risk parameter is a statistical artifact which is of little practical interest in this particular application except as it yields the cost of equity capital. Therefore, the simulations and forecasts which follow will deal directly with values of R_i, because this is the true endogenous variable in the specification of equations (9) and (11). Second, prediction of market rates of return derived as they are from stock market data is an inherently difficult task.

The second equation in Table 1 was used to produce an historical simulation over the period 1958-67 and an ex post forecast from 1968-73. The numerical results are shown as Table 3 and a plot of the actual versus fitted values is in Figure 2. Both the historical simulation and ex post forecast perform adequately in that the per cent errors, RMS errors, and other summary measures are within acceptable bounds. Also the fitted values track most of the turning points in the actual series. The most serious problem seems to be that the simulation and forecast do not register as much variability as the actual values. That is, the equation picks up the trend and turning points in the actual series but does not show as much of the scatter. Also 1969 and 1970 were more difficult to predict than any other years except for the endpoints. This difficulty most likely occurred because of the large swing in the actual data from 1969 to 1970. Such a result indicates that forecasting $R_{i,1975}$ will also be troublesome since in that year there was a jump of eighty percentage points over levels in the previous year.

A second experiment was to analyze what difference the heteroscedastic correction made for forecasting purposes. The third and fourth equations in Table 2 are identical except that the latter is estimated with transformed data. These equations were simulated and forecasted in the same manner. The results shown in Tables 4 and 5 and Figures 3 and 4 are quite similar and underscore the fact that correcting for heteroscedasticity has had little effect on the forecasting ability of equation (9).

The last historical simulation and ex post forecast was done to evaluate the impact that additional years of data would have on the accuracy of the estimates. Equation 6) in Table 2 was estimated over the period 1958-71 so that the historical simulation ran over this same time period and the ex post forecast was just for the single year, 1972. The results in Table 6 and Figure 5 are as one would expect in that the actual series is tracked well on its turning points, but the simulation does not register as much variability as the actual R_i. The simulated values for 1958 and 1969 have the largest percentage errors obviously due to the fact that the actual values in these two years were at the extremes of the sample. It is interesting to note that the simulation and forecast in Table 6 is not qualitatively different from the results of Table 3, although the former estimation had the benefit of four additional years of data.

As a final test of the robustness of this model of risk determination an ex ante forecast was made through 1976. Because actual values of R_i are available up through 1975, whereas many of the exogenous variables only run to 1972 or 1973, part of the forecast was also in actuality an ex post forecast conditional upon

the values chosen for the exogenous inputs. Equation (6) in Table 2 was again selected as the forecasting vehicle. Values for the majority of the exogenous variables were generated based on data reported in the Value Line Survey of the electric utility industry. This service reports a number of financial indicators on an historical and forecast basis for most of the firms in the sixty-two firm sample. Based on the Value Line analyses, growth rates were computed for MVBV, ICONST, EVAR, and LGAST and these series were linearly extrapolated out to 1976. Also Value Line offers an historical account and their own speculation on the results of many regulatory hearings so that DECDUM could be constructed on this basis. CPICH, R_F, and R_{mF} were assigned values based on a survey of the more recent results of several of the large macroeconomic models.

The results of the forecasting exercise are shown in Figures 6 and 7 and Table 7.Perhaps not surprisingly, the model does not replicate well the most recent years of experience. This poor performance is primarily due to the very large degree of variability in the actual series. The percent errors for the period 1973-1975 were -25.2%, -31.5%, and +33.8% respectively, underscoring the extent to which the forecast was unable to track closely the level of the actual series. The turning points in the actuals are captured, however. Some of the summary measures of the goodness of fit indicate that the forecast is a fairly unbiased approximation of the actual series and that overall the results are acceptable considering the highly volatile nature of the stock market-based returns data. Also, an analysis of the residuals of the simulation and forecast, as shown in Figure 7, revealed that there was not a large degree of serial dependency. One might presume that the forecast would have been more successful had it not been over a period which had the largest year-to-year changes in rates of return.

4.0 Concluding Remarks

This paper has had multiple objectives. The empirical determinants of systematic risk were evaluated as a means for analyzing recent performance characteristics of the electric utility industry. By far, the thorniest issue in most regulatory rate proceedings is the ascertainment of a fair rate of return for the particular utility. The methods employed here are embedded in a sound theoretical model of the risk-return tradeoff and provide an opportunity for determining an utility's required rate of return on equity based on the firm's financial and regulatory environment. It is particularly interesting to note the significant effects that the regulatory process, itself, can have on the economic performance of the industry.

In the early 1970's rate of return regulation was not working well. Commissions were often too slow in responding to the rate requests of their regulated firms and this along with sharply rising energy costs pushed a number of firms to the brink of bankruptcy. Although such failures were avoided, there are a number of lessons for regulatory practice to be drawn from recent experience as elucidated in this model. First, the fact that a public utility commission hands down a decision has a positive effect on the firm's economic status. Clearly, in many situations the commission will not grant the entire amount requested by the firm, but any amount greater than zero will offer some relief. In times of rising average costs the commission has a large degree of control over the firm and this control is registered in the firm's stock prices and corresponding required rates of return.

This power to control the firm is also reflected in the results for MVBV and CPICH. Stringent regulation which forces the firm toward (or below) its allowed rate of return perhaps by not permitting it to pass along exogenous increases in factor costs will impair the performance of the utility and possibly confiscate its assets. Conversely, regulation which is very loose will expose the firm to more risk for which investors will expect a return. As always, regulators must walk the tightrope between either allowing too little and forcing the firm out of business or allowing too much and impoverishing consumers and bestowing windfalls upon the firm and its stockholders.

The accounting-related aspects of the regulatory environment, i.e. FLOW, ICONST, and FAIR, apparently play a less important, but not insignificant, role in explaining differential required rates of return. Firms that are in fair value jurisdictions do indeed appear to be less risky since they have larger rate bases. Their allowed rates are presumably lower. Their expected rates of return are also correspondingly lower. There is some disagreement in the literature as to the effect that flow through accounting actually has upon the regulated utility's systematic risk. The results support the theoretical direction of the effect but it is not a large or statistically significant effect. An increase in the allowance for funds used during construction (AFDC) seems to increase the level of systematic risk for the firm. This is a somewhat puzzling result because increases in AFDC should tighten the regulatory constraint which would thereby decrease systematic risk. However, there are a number of effects tied into this because increases in AFDC, which are treated as a revenue item by the regulatory commission, also decrease the amount of funds available for dividends. It is often argued in empirical studies of risk determination that the dividend payout and a firm's β are inversely related. This factor may best explain the results obtained for ICONST.

The financial environment as defined here in terms of several of the variables often used in empirical work does not explain as much of the variance in the cost of capital as does the regulatory environment. Only the size of firm performs well as an explanatory variable. This supports the intuitive belief that large firms are probably safer than small ones and may be related to an hypothesis of risk determination developed by Myers and Turnbull. Several other variables relating to leverage, earnings variability, and growth do not provide results consistent with previous work on this problem. This is most likely due to the failure of other analyses to reflect adequately the complex and important effects that various regulatory instruments have upon the electric utility.

The model performs adequately as a tool for simulating past behavior and forecasting future required rates of return. The model is fairly robust in that it tracks well and hits every major turning point. The failure of this single equation model to replicate closely the actual level in required rates of return is a function both of the model's simplicity and the complicated nature of stock market returns. It is not clear if ex post returns are an entirely proper proxy for ex ante rates of return. Possibly ex ante returns have smaller variances than realized returns so that the results of the simulation and forecasting exercise are actually better than they appear to be.

	$\alpha_0 R_{mF}$	LGAST	AGROW	EVAR	ICONST	MVBV	CPICH	LEVER	LHSMEAN (SER)	R^2	Period
1)	5.62 (.87)	-.75 (.10)	.27 (1.71)	-5.30 (2.04)	.16 (.06)	.06 (.005)			.11 (.15)	.20	1958-'67
2)	6.54 (.96)	-.75 (.10)	1.38 (1.80)	-6.81 (2.15)	.17 (.06)	.06 (.005)	-23.64 (10.70)		.11 (.15)	.19	1958-'67
3)	4.41 (1.37)	-.43 (.10)		-7.24 (2.14)	.09 (.06)	.04 (.005)	132.36 (12.58)	-1.68 (1.24)		.32	1958-'65
4)	1.17 (.62)	-.64 (.10)	1.48 (1.78) DECDUM		.06 (.06)	.04 (.004)	138.99 (12.55)		.15 (.13)	.33	1958-'65
5)	6.61 (.95)	-.75 (.10)	.56 (.30)	-7.03 (2.15)	.17 (.06)	.05 (.005)	-21.90 (10.22)		.11 (.15)	.19	1958-'67
6)	3.13 (.84)	-.22 (.09)	.33 (.26)		.03 (.04)	.03 (.004)	-91.35 (10.17)	- 6.1 (1.06) FLOW	.08 (.11)	.36	1959-'67
7)	3.81 (.80)	-.49) (.07)	.41 (.29)	-4.01 (1.95)		.05 (.004)		.15 (.13)	.08 (.12)	.24	1959-'67
8)	2.82 (.42)	-.22 (.07)				.03 (.004)	-89.47 (8.94)	.03 (.12)	.08 (.11)	.36	1958-'67

Table 1. Regression Results for IV Estimation of Equation (9).

(Standard Errors in Parentheses)

	$\alpha_0 R_{mF}$	LGAST	FAIR	DECDUM	EVAR	FLOW	MVBV	ICONST	AGROW	LHSMEAN (SER)	R^2	Period
1)	5.94 (.96)	-.28 (.09)	-.25 (.16)	.79 (.32)	-8.55 (2.41)	.04 (.16)	.08 (.02)			.15 (.15)	.05	1958-'65
2*)	4.92 (.79)	-.21 (.09)	-.20 (.16)	.73 (.32)	-7.02 (2.13)	.05 (.17)	.09 (.02)			(.03) (.03)	.10	1958-'65
						CPICH						
3)	6.18 (1.02)	-.65 (.11)			-3.29 (2.24)	-45.35 (11.11)	.11 (.02)	.19 (.06)	2.23 (1.92)	.11 (.16)	.07	1958-'68
4*)	3.82 (.79)	-.53 (.09)			.10 (1.92)	-10.70 (8.19)	.12 (.02)	.15 (.06)	2.12 (1.68)	.02 (.03)	.11	1958-'68
5)	2.65 (.76)	-.45 (.08)			3.57 (1.79)	-21.60 (4.75)	.10 (.02)	.03 (.02)	1.54 (1.48)	.09 (.15)	.12	1958-'71
6)	2.82 (.76)	-.45 (.08)		.51 (.24)	3.11 (1.80)	-20.28 (4.43)	..11 (.02)	.03 (.02)		.09 (.15)	.13	1958-'71

*estimated with heteroscedastic correction

Table 2. Regression Results for IV Estimation of Equations (9) and (11).

(Standard Errors in Parentheses)

TABLE 3

HISTORICAL SIMULATION AND EX POST FORECAST OF EQUATION (2) FROM TABLE 1.

	ACTUAL*	FITTED*	RESIDUAL
1958	1.37968	1.14402	0.235662
1959	1.07213	1.14444	-0.072308
1960	1.2227	1.14636	0.076339
1961	1.31273	1.19665	0.116086
1962	1.01467	1.12487	-0.110204
1963	1.10284	1.12341	-0.020567
1964	1.17052	1.13044	0.040086
1965	1.01872	1.10065	-0.08193
1966	0.945821	1.06203	-0.116214
1967	0.964505	1.04944	-0.084931
1968	1.14167	1.02654	0.115124
1969	0.861708	0.988827	-0.127119
1970	1.16734	0.995275	0.172069
1971	1.03478	1.04986	-0.015082
1972	1.07035	1.0856	-0.015248
1973	0.836171	1.0146	-0.178432
1974	0.758317	NA	NA
1975	1.55787	NA	NA

	PCER
1958	0.170809
1959	-0.067443
1960	0.062435
1961	0.088431
1962	-0.10861
1963	-0.018649
1964	0.034246
1965	-0.080425
1966	-0.122871
1967	-0.088056
1968	0.100838
1969	-0.14752
1970	0.147402
1971	-0.014575
1972	-0.014246
1973	-0.213392
1974	NA
1975	NA

RMS Error = .17

RMS % Error = 16.51%

*Units for all actual and fitted values are in (1.0+ rate of return) or wealth relatives. To convert to a percentage rate of return, subtract 1.0 and multiply by 100.

TABLE 4

HISTORICAL SIMULATION AND EX POST FORECAST OF EQUATION (3) FROM TABLE 2

	ACTUAL	FITTED	RESIDUAL	PCER
1958	1.37968	1.11336	0.26632	0.19303
1959	1.07213	1.1656	-0.093469	-0.08718
1960	1.2227	1.13572	0.086978	0.071136
1961	1.31273	1.15943	0.1533	0.11678
1962	1.01467	1.12926	-0.114595	-0.112939
1963	1.10284	1.13749	-0.03465	-0.031419
1964	1.17052	1.12989	0.04063	0.034711
1965	1.01872	1.11476	-0.096048	-0.094284
1966	0.945821	1.06504	-0.119222	-0.126051
1967	0.964505	1.07602	-0.111514	-0.115618
1968	1.14167	1.02949	0.112179	0.098259
1969	0.861708	0.998271	-0.136563	-0.158479
1970	1.16734	1.00448	0.162866	0.139518
1971	1.03478	1.09721	-0.062431	-0.060333
1972	1.07035	1.16771	-0.097362	-0.090962
1973	0.836171	1.07294	-0.236764	-0.283152
1974	0.758317	NA	NA	NA
1975	1.55787	NA	NA	NA

RMS Error = .18

RMS % Error = 18.72

TABLE 5

HISTORICAL SIMULATION AND EX POST FORECAST OF EQUATION (4) FROM TABLE 2.

	ACTUAL	FITTED	RESIDUAL	PCER
1958	1.37968	1.14322	0.23646	0.171387
1959	1.07213	1.14511	-0.07298	-0.06807
1960	1.2227	1.13243	0.090267	0.073826
1961	1.31273	1.14646	0.166268	0.12665 3
1962	1.01467	1.12102	-0.106354	-0.104816
1963	1.10284	1.12761	-0.024774	-0.022463
1964	1.17052	1.11745	0.053076	0.045344
1965	1.01872	1.10889	-0.090175	-0.088518
1966	0.945821	1.09179	-0.145974	-0.154336
1967	0.964505	1.09898	-0.134474	-0.139423
1968	1.14167	1.09577	0.045896	0.040201
1969	0.861708	1.08929	-0.227584	-0.264108
1970	1.16734	1.10674	0.060599	0.051912
1971	1.03478	1.14583	-0.111053	-0.107321
1972	1.07035	1.18526	-0.114906	-0.107354
1973	0.836171	1.15741	-0.321242	-0.384182
1974	0.758317	NA	NA	NA
1975	1.55787	NA	NA	NA

RMS Error = .19

RMS % Error = 19.74%

TABLE 6

HISTORICAL SIMULATION AND EX POST FORECAST OF EQUATION (6) FROM TABLE 2.

	ACTUAL	FITTED	RESIDUAL	PCER
1958	1.37968	1.12749	0.252197	0.182793
1959	1.07213	1.15666	-0.084532	-0.078844
1960	1.2227	1.14032	0.082381	0.067376
1961	1.31273	1.16046	0.152267	0.115993
1962	1.01467	1.13687	-0.122203	-0.120436
1963	1.10284	1.13708	-0.034237	-0.031044
1964	1.17052	1.12484	0.045678	0.039024
1965	1.01872	1.11096	-0.092247	-0.090552
1966	0.945821	1.06994	-0.12412	-0.13123
1967	0.964505	1.07596	-0.111451	-0.115553
1968	1.14167	1.05531	0.086357	0.075641
1969	0.861708	1.03268	-0.170971	-0.19841
1970	1.16734	1.03691	0.130435	0.111737
1971	1.03478	1.06695	-0.032164	-0.031083
1972	1.07035	1.09226	-0.021909	-0.020469
1973	0.836171	NA	NA	NA
1974	0.758317	NA	NA	NA
1975	1.55787	NA	NA	NA

RMS Error = .15

RMS % Error = 13.72

TABLE 7

EX ANTE FORECAST OF EQUATION (6) FROM TABLE 2

	ACTUAL	FITTED	RESIDUAL	PCER
1958	1.37963	1.12749	0.252197	0.182793
1959	1.07213	1.15666	-0.084532	-0.078844
1960	1.2227	1.14032	0.082321	0.067376
1961	1.31273	1.16046	0.152267	0.115993
1962	1.01467	1.13687	-0.122203	-0.120436
1963	1.10284	1.13708	-0.034237	-0.031044
1964	1.17052	1.12484	0.045678	0.039024
1965	1.01272	1.11096	-0.092247	-0.090552
1966	0.945821	1.06994	-0.12412	-0.13123
1967	0.964505	1.07596	-0.111451	-0.115553
1968	1.14167	1.05531	0.086357	0.075641
1969	0.861708	1.03268	-0.170971	-0.19841
1970	1.16734	1.03691	0.130435	0.111737
1971	1.03478	1.06695	-0.032164	-0.031083
1972	1.07035	1.09226	-0.021909	-0.020469
1973	0.836171	1.04655	-0.210379	-0.251597
1974	0.758317	0.997467	-0.23915	-0.315369
1975	1.55787	1.03192	0.525949	0.337607
1976	NA	1.08231	NA	NA

RMS Error = .21
RMS Percent Error = 19.49%

Correlation Between Actual and Forecast = .26
Mean Square Error (MSE) = $(\text{Bias})^2$ + Variance

MSE = 4.5E-06 + .045

FIGURE 1

MEAN ANNUAL MARKET RATES OF RETURN, $\bar{R}_t$

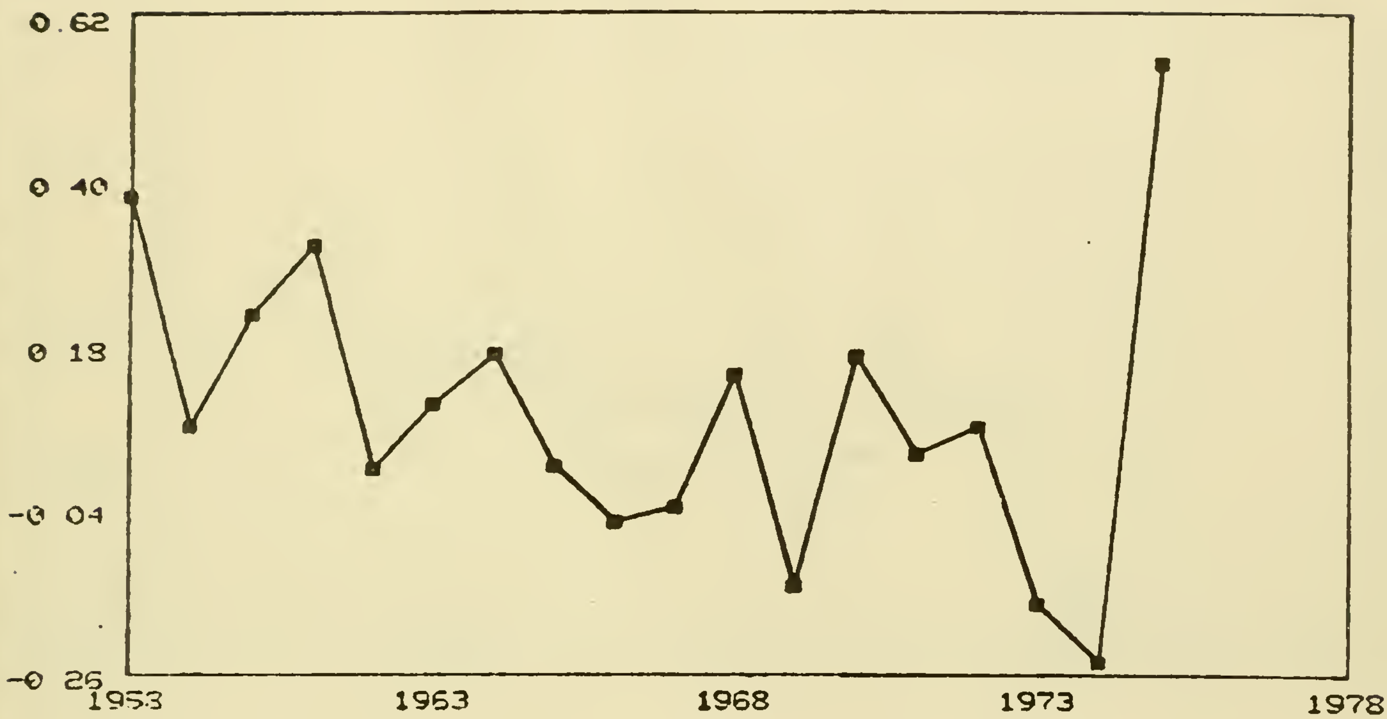


FIGURE 2

ACTUAL AND FITTED VALUES FROM TABLE 3

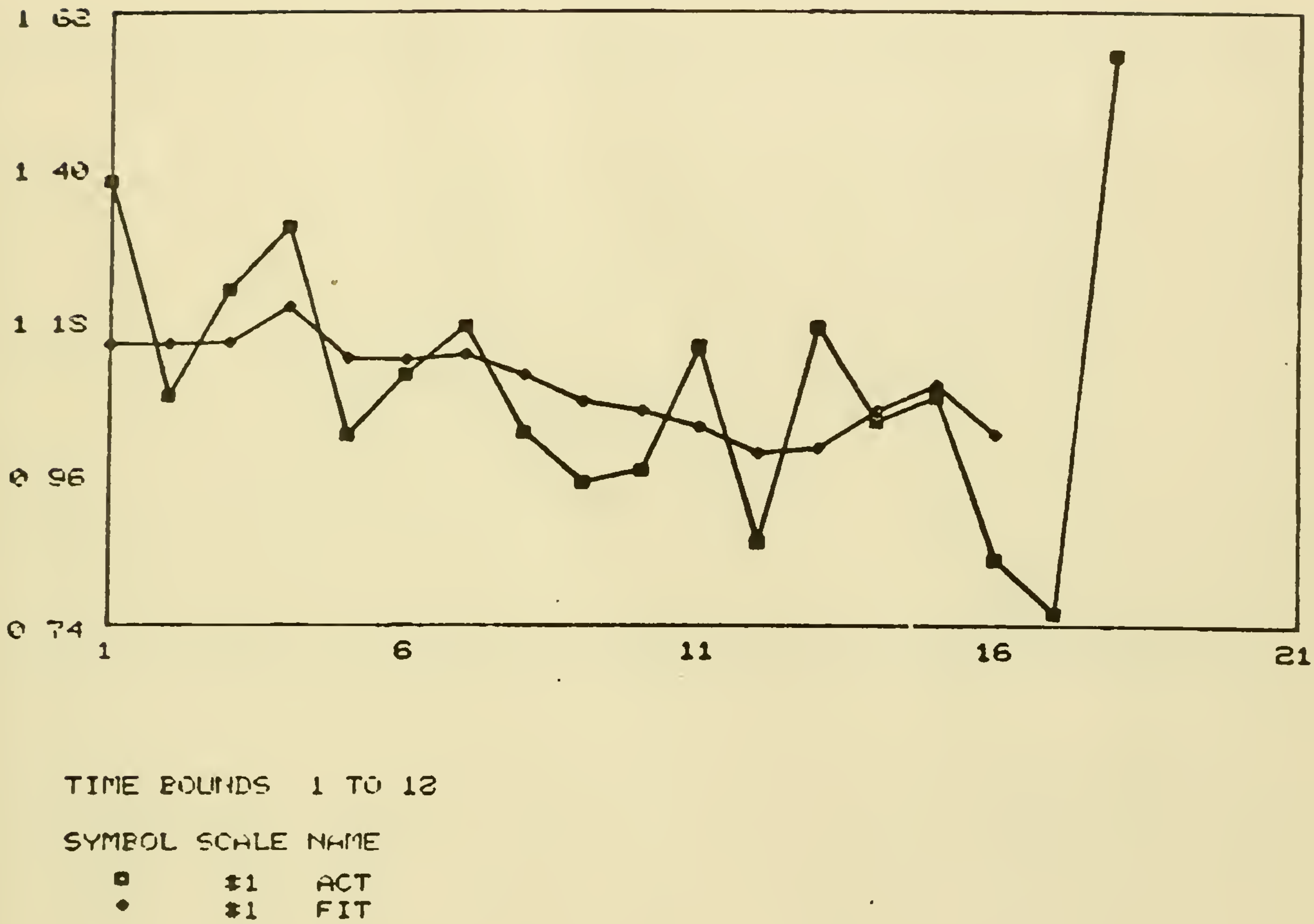
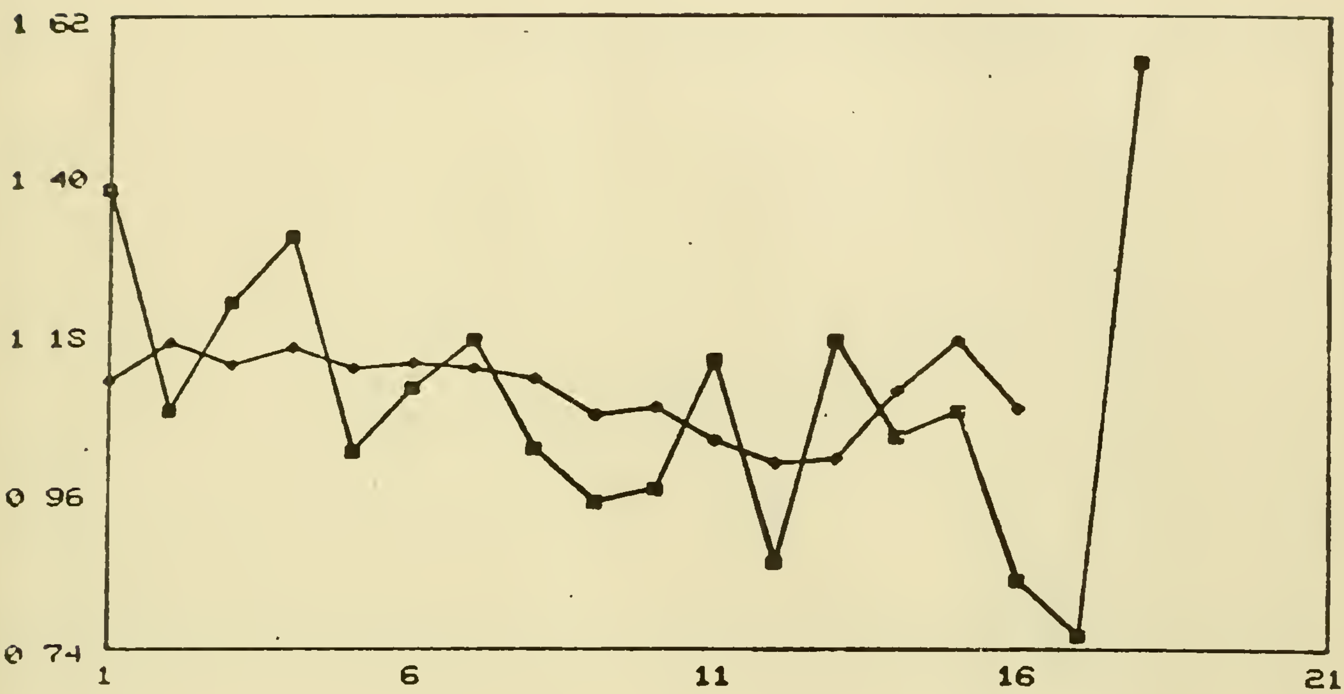


FIGURE 3

ACTUAL AND FITTED VALUES FROM TABLE 4



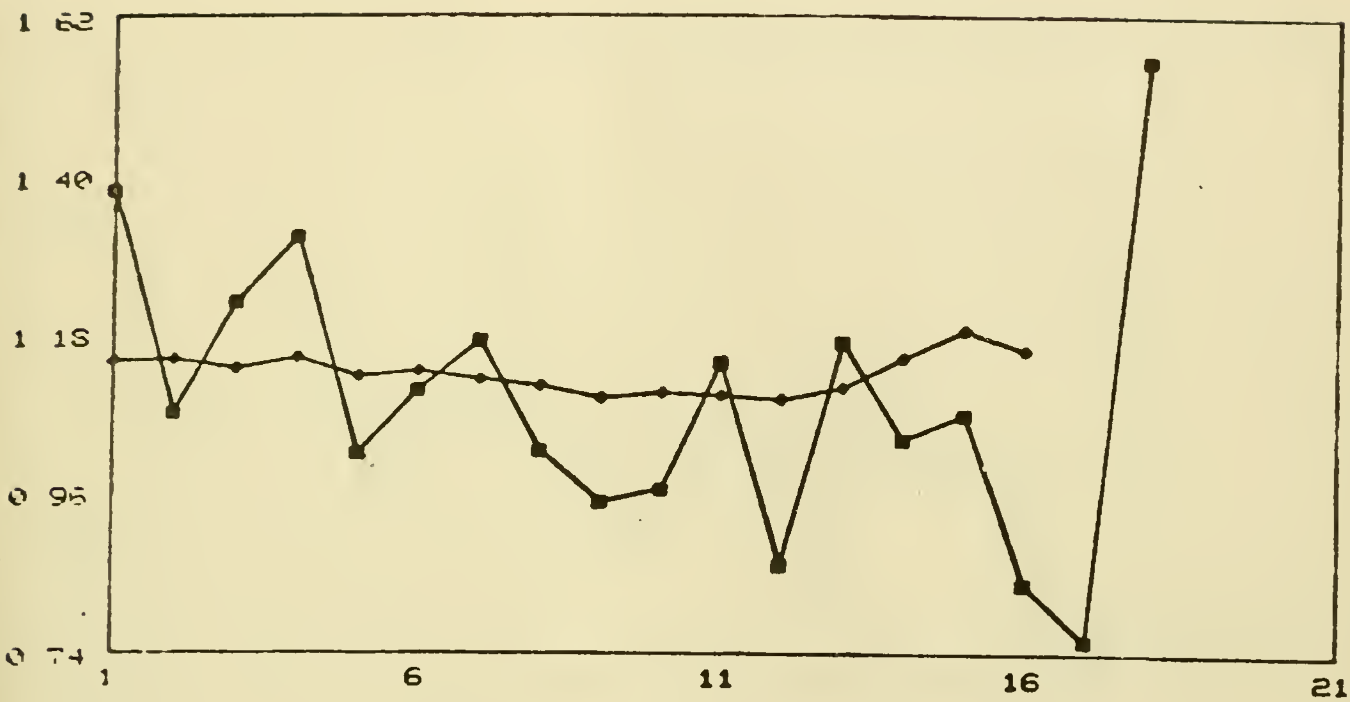
TIME BOUNDS 1 TO 18

SYMBOL SCALE NAME

SYMBOL	SCALE	NAME
▫	#1	ACT
◆	#1	FIT

FIGURE 4

ACTUAL AND FITTED VALUES FROM TABLE 5

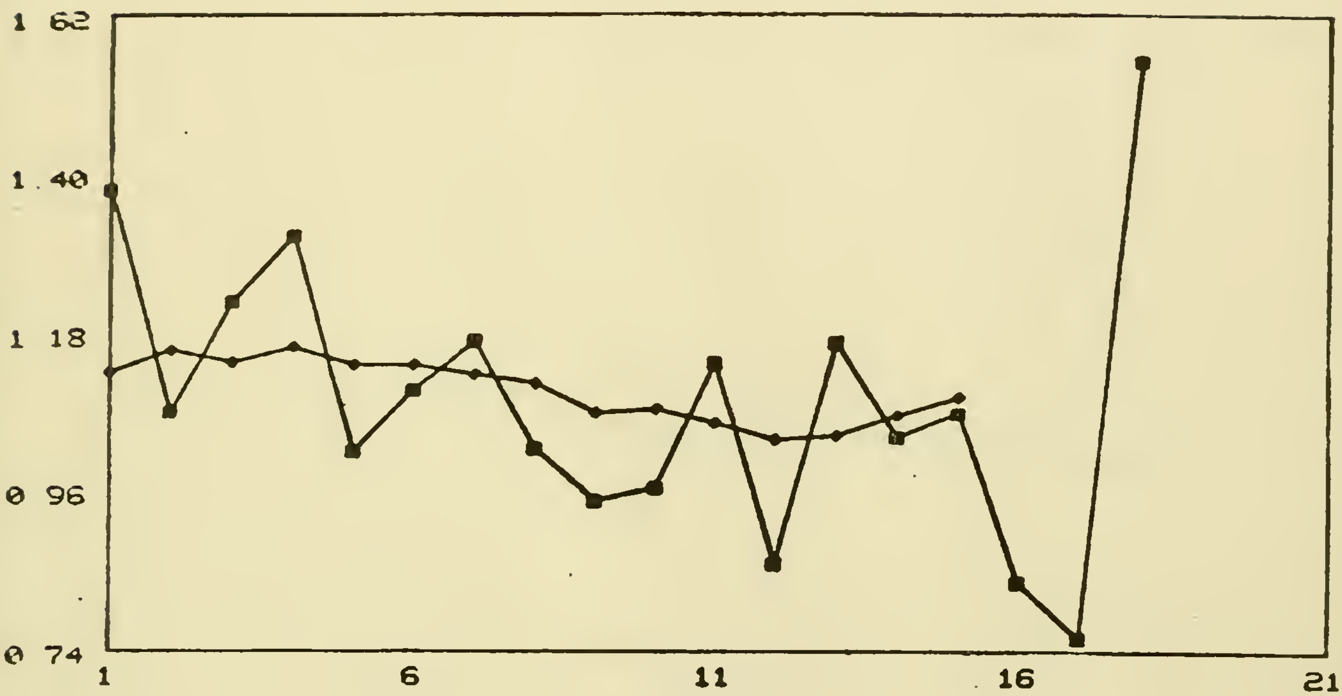


TIME BOUNDS 1 TO 18

SYMBOL	SCALE	NAME
▪	*1	ACT
•	*1	FIT

FIGURE 5

ACTUAL AND FITTED VALUES FROM TABLE 6



TIME BOUNDS 1 TO 18

SYMBOL SCALE NAME

SYMBOL	SCALE	NAME
▫	*1	ACT
•	*1	FIT

FIGURE 6

ACTUAL AND FITTED VALUES FROM TABLE 7

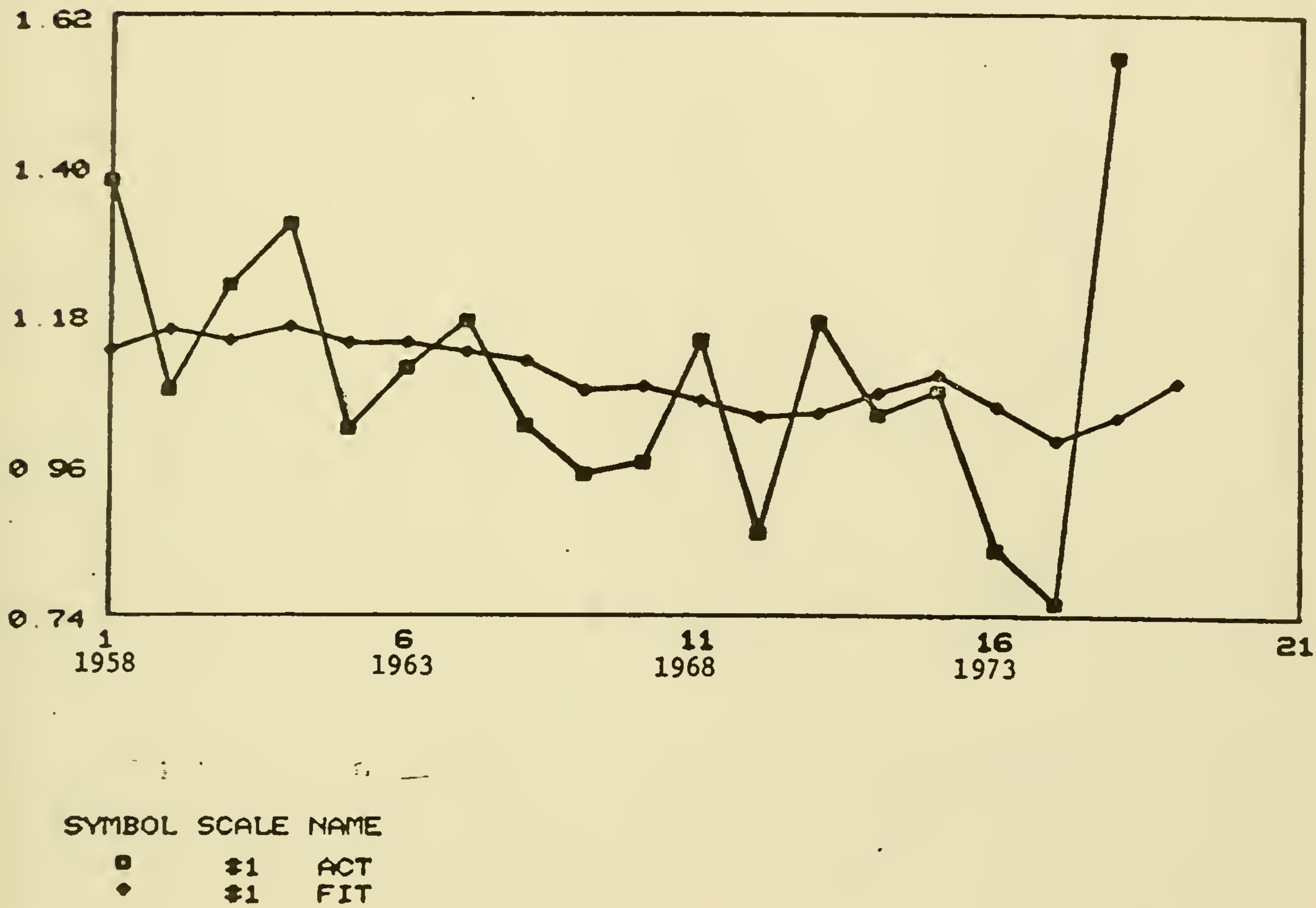
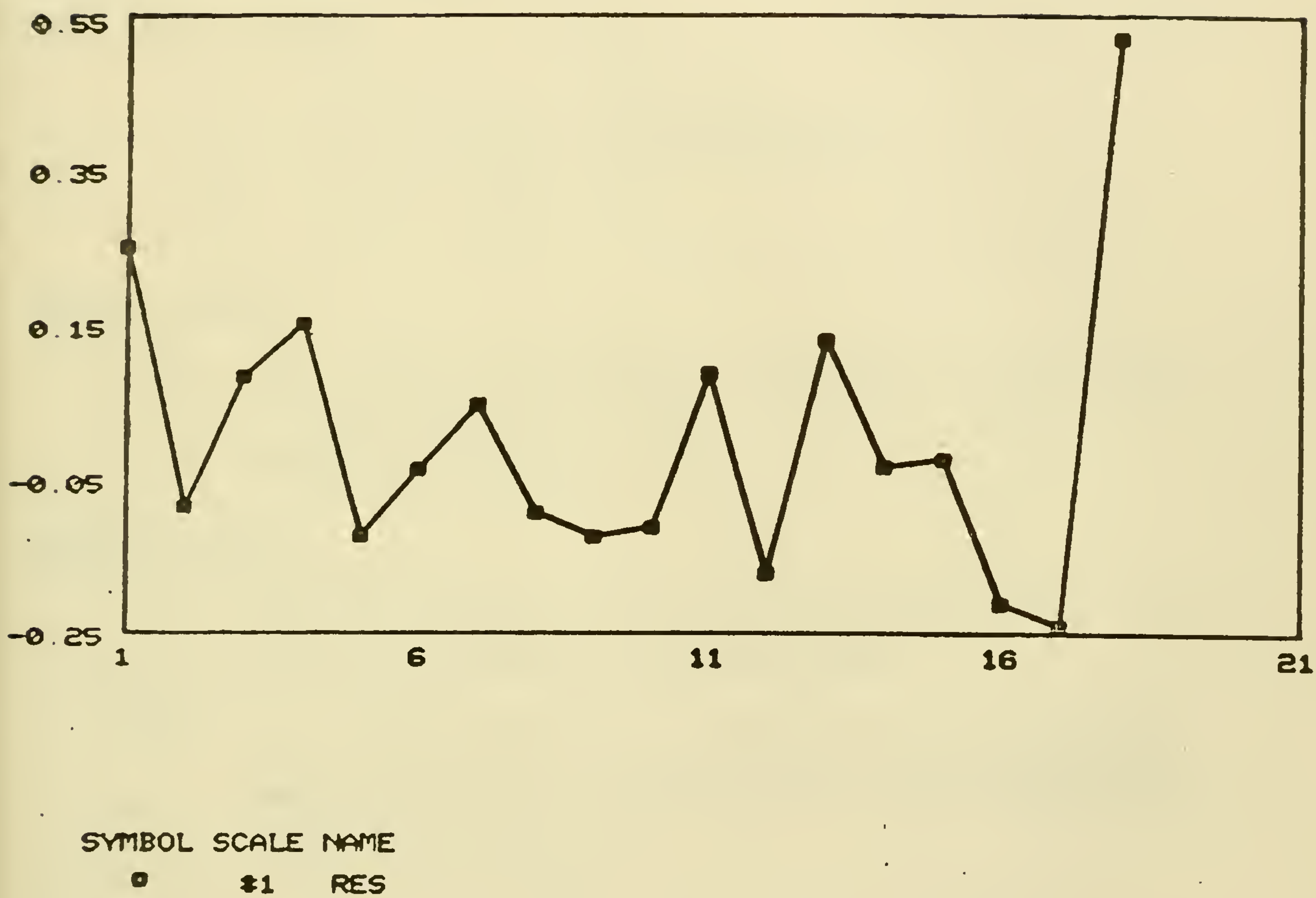


FIGURE 7

RESIDUALS FROM TABLE 7



APPENDIX

DEFINITION AND SOURCES OF INDEPENDENT VARIABLES

Regulatory Environment Variables

Depreciation Practice

$$\text{FLOW} = \begin{cases} 0 \text{ if firm uses Normalized Accounting} \\ 1 \text{ if firm uses Flow Through Accounting} \end{cases}$$

Source: COMPUSTAT Utility Tape

Interest Charges

ICONST = Dollar Amount of Allowance for Funds Used During Construction

Source: COMPUSTAT Utility Tape

Valuation Method

$$\text{FAIR} = \begin{cases} 0 \text{ if state commission uses Original Cost Method} \\ 1 \text{ if state commission uses Fair Value Method} \end{cases}$$

Source: H. C. Peterson, The Effect of Regulation on Production Costs and Output Prices in the Private Electric Utility Industry, Memo No. 151, Center for Research in Economic Growth, Stanford University, September 1973.

Inflation Rate (Consumer Price Index)

$$\text{CPICH} = \Delta(\text{CPI})/\text{CPI}_{t-1}$$

Source: Survey of Current Business, Department of Commerce

Market-Book Ratio

$$\text{MVBV} = \frac{\text{Price per share*Total Shares Outstanding}}{\text{Total Book Stockholders Equity and Total Liabilities}}$$

Source: COMPUSTAT Utility Tape

Rate Case Decision

$$\text{DECDUM} = \begin{cases} 1 & \text{if commission rendered a decision in this year} \\ 0 & \text{otherwise} \end{cases}$$

Source: Private sources and Wood, Struthers, & Winthrop, Inc., The Changing Pattern of Utility Rates of Return, unpublished memo, September 1971.

Financial Environment Variables

Asset Growth

$$\text{AGROW} = \Delta[\text{Assets(Total)}]$$

Leverage

$$\text{LEVER} = \frac{\text{Total Liabilities + Long Term Debt + Preferred Stock}}{\text{Liabilities + Total Stockholders Equity}}$$

Asset Size

$$\text{LGAST} = \log(\text{Total Assets})$$

Earnings Variability

$$\text{EVAR} = [(\text{RETN} - \text{RETBAR})^2]^{.5}$$

where

$$\text{RETN} = \frac{\text{Net Income After Minority Interest}_t}{\text{Closing Stock Price}_{t-1} * \text{Common Shares Outstanding}_{t-1}}$$

$$\text{RETBAR} = \frac{\left(\sum_{t=1}^{T} \text{Net Income}_t / \text{Market Value of Common Stock}_{t-1}\right)}{T}$$

Market Variables

Company Returns

$R_{i,t}$ = annual market return for firm i in period t. (See equation (2) in text).

Source: CRSP Tape.

Market Returns

$R_{m,t}$ = Rate of return on common stocks based on the Standard & Poor's Composite Index for year t.

Source: R. G. Ibbotson and R. A. Sinquefield, "Stocks, Bonds, Bills, and Inflation: Year-by-Year Historical Returns," Journal of Business, January 1976.

Risk Free Rate

$R_{F,t}$ = Rate of Return on U.S. Treasury Bills for year t.

Source: Ibbotson and Sinquefield, op. cit.

List of Companies in Sample

Atlantic City Electric
Baltimore Gas and Electric
Boston Edison
Carolina Power and Light
Central Hudson Gas and Light
Central Illionis Light
Central Illinois Public Service
Cincinnati Gas and Electric
Cleveland Electric Illuminating
Columbus and Southern Ohio Electric
Commonwealth Edison
Consolidated Edison
Consumers Power Co.
Dayton Power and Light
Delmarva Power and Light
Detroit Edison Co.
Duquesne Light Co.
Empire Dist. Electric
Florida Power Corp.
Florida Power and Light
Gulf States Utilities
Idaho Power Co.
Illinois Power Co.
Indianapolic Power and Light
Interstate Power Co.
Iowa-Illinois Gas and Electric
Iowa Power and Light
Kansas City Power and Light
Kansas Power and Light
Long Island Lighting
Louisville Gas and Electric
Middle South Utility
Minnesota Power and Light
Montana-Dakota Utility
Montana Power Co.
New England Electric System
N.Y. State Electric and Gas
Niagara Mohawk Power
North States Power Min.
Ohio Edison Co.
Oklahoma Gas and Electric
Pacific Gas and Electric
Pennsylvania Power and Light
Philadelphia Electric
Potomac Electric Power
Public Service of Colorado
Public Service of Indiana
Public Service Electric and Gas
Rochester Gas and Electric
St. Joseph Light and Power
San Diego Gas and Electric
So. Carolina Electric and Gas
So. California Edison
So. Indiana Gas and Electric
Southwestern Public Service
Texas Utilities Co.
Toledo Edison Co.
Utah Power and Light
Virginia Electric and Power
Washington Water Power
Wisconsin Electric Power
Wisconsin Public Service

NOTES

1. The initial work in this area is reported in W. F. Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk," Journal of Finance, September 1964; Lintner, J., "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," Review of Economics and Statistics, February 1965; Mossin, J., "Equilibrium in a Capital Asset Market," Econometrica, October 1966.

2. Joskow, P. L. and P. W. MacAvoy, "Regulation and the Financial Condition of the Electric Power Companies in the 1970's," American Economic Review, May 1975, p. 297-8.

3. S. A. Breyer and P. W. MacAvoy, Energy Regulation by the Federal Power Commission, Brookings, Washington, D.C., 1974, pp. 23-4.

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