REGULATION AND ELECTRIC UTILITY RISK AND PERFORMANCE: AN EMPIRICAL EXAMINATION

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ABSTRACT

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The objective of this study was to assess the relationship between risk and performance measures associated with electric utility portfolios of varying regulatory climate. Regulatory climate represents a measure of how a regulatory commission's policy affects the perceived level and predictability of a utility's security cash flows.

The electric utility industry in the United States is governed largely by state regulatory commissions. In regulating rates, quality of service, and returns to capital, a close association has developed between the regulators and the regulated firms. The association may be a factor in how investors' perceive the risk of electric utility common stock. Moreover, to the extent that the policy instruments applied by regulators vary across state

commissions, there may be differential perceptions of regulatory effects. Recognitions of this potential effect has led to use of the term "regulatory climate."

Market based research was employed to examine the relationship between regulatory climate and measures of risk and return performance. The primary assumption underlying this approach is the efficiency of security markets. This allows us to assert that if measures of regulatory climate provide useful information to the market, there should be observable differences in market related measures of risk.

The firms included in this study are large electric utilities whose return and regulatory data were available from public sources. Two regulatory portfolios were created; one represented climate, the other was composed of firms with an average regulatory climate. Ordinary least squares and the market model were used to estimate the risk and return measures of the two regulatory portfolios.

The results of this analysis suggest that pervasive risk differences existed between regulatory portfolios. In general, portfolios of average regulatory rank had higher levels of measured risk than did portfolios of favorable regulatory rank. The market's perceptions of the riskiness of electric utility firms was found to be associated with the regulatory climate ranking provided by the investment advisory services. It appears that the more favorable the regulatory climate a utility was exposed to, the lower the related risk and, by association, equity costs. Measures of return performance for each portfolio indicated that while the favorable utility had a higher level of risk adjusted returns, neither portfolio had excess returns significantly different than zero.

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INTRODUCTION

The electric utility industry has largely been governed by state regulatory commissions since the late 1920's. Rates, quality of service and returns to capital have been regulated in an effort to provide reliable service at reasonable rates. In so doing, a close association has developed between the regulated firms and their regulators. That association may be a factor in how investors' perceive the risk of electric utility common stock. Moreover, to the extent that the policy instruments applied by regulators vary across state commissions, there may be differential perceptions of regulatory effects. Recognition of this potential effect has led to use of the term "regulatory climate." The intent of this measure is to differentiate between commissions on the basis of the perceived effect of regulation on the relative level and predictability of earnings.

It is the purpose of this research to examine the relationship between investors' perceptions of regulatory climate and market measures of security risk. A secondary goal is to define the problem of regulatory risk and regulatory climate and examine how investors' perceptions of these concepts may impact security cash flows.

Regulatory risk exists in a conceptual sense and can be defined as an absolute measure of the perceived impact that regulatory commission actions have on the level and variability of a regulated firm's security cash flows. Intuitively, we would expect regulatory risk to be related to the consistency of a commission's policy, the allowed level of earnings over time, and earnings variability associated with policy tools employed by the commission.

While we may be able to define regulatory risk in a conceptual sense, we can, at best, measure it only in a relative sense. That measurement is through the use of agency ratings of regulatory climate. Regulatory climate is closely related to the concept of regulatory risk. In this research, it will represent a relative measure of how a commission's policy affects the perceived level and predictability of a utility's security cash flows. As such, if the regulatory risk could be measured, we would expect a high positive correlation between regulatory risk and regulatory climate.

Over twenty agencies rank regulatory commissions according to the relative investment climate within their respective states [1]. These industry analysts note that regulatory climate differs across commissions and may affect the risk/return characteristics of regulated firms through its impact on expected earnings. Regulatory effects are assumed to be reflected in these rankings, in that the rankings reflect the analysts' perceived effect of regulation. These rankings will be used as a measure of regulatory climate. The assumption is made that the net effect of all regulatory decisions is reflected in the regulatory rank assigned a state jurisdiction. These rankings will be used as a relative measure of how regulatory risk is perceived by investors. They will be employed in this research to distinguish between utility firms with potentially different risk profiles.

A review of the financial literature covering regulatory risk and regulatory climate indicates that the relationship between regulatory risk (climate) and investors' perceptions of risk is an issue of concern and ambiguity. In general, it may be stated that this concern is reflective of a desire to provide an accurate indication of the relative investment risk of an electric utility. The ambiguity of the issue is made evident by noting first that the term regulatory risk is often used but rarely defined. Second, while the underlying assumption in the literature is that there is a positive relationship between regulatory risk (climate) and an electric utility's cost of capital, neither theoretical or empirical evidence has been advanced to conclusively demonstrate this relationship. The present research is motivated by a desire to lend both empirical and conceptual support to the issues associated with regulatory climate and an electric utility's risk profile.

Specifically, the research tests the linkage between regulatory climate and risk measures and develops a cash flow model that posits how regulation might impact security cash flow risk. None of the theoretical or empirical work to date has directly addressed the issue of differential regulatory climate and the regulated firm's risk profile. Prior studies have utilized regulatory climate as a factor in return-generating models, but did not approach the issue through consideration of risk components.

There are a number of research approaches which could have been used to examine the relationship between regulatory climate and security risk measures. The approach employed in this study can be characterized as market based research. The primary assumption underlying this approach is the efficiency of the security markets. An efficient capital market implies that security prices reflect all useful information available to market participants, quickly, and without bias in the aggregate. This allows us to assert that if measures of regulatory climate provide useful information to the market, there should be observable differences in market related measures of risk. One method of testing for these differences would be to examine the differences between measures of security return risk of firms differentiated only by regulatory climate. A finding of significant differences would provide evidence of the information content of the regulatory climate rankings.

The research here used the equilibrium asset pricing model developed by Sharpe (1964), Lintner (1965) and Mossin (1966) to develop market measures of risk. The relationship between a measure of regulatory climate and these market risk measures was then investigated by comparing portfolios of firms whose commissions have been assigned a different regulatory climate ranking. The basis for this approach was derived from an analytical model which relates an utility's perceived equity risk to the regulatory policy associated with a particular regulatory climate. The analytical model is based upon the asset pricing model from which the risk measures were developed. Thus, this study is a joint test of the descriptive validity of the theoretical asset pricing model underlying the risk measures, as well as a test of the information content of regulatory climate data.

The results of the study should be of interest to three identifiable groups of users: (1) the investment community, (2) the managers of publicly held electric utilities and, (3) regulatory policy makers.

The interest of the investment community in this topic is founded in financial theory. Asset pricing models have linked asset valuation to variability in an asset's cash flows. Because risk assessment is an essential input to investment decisions, knowledge of factors contributing to cash flow variability is important in making effective decisions. Findings of support for the proposed relationship will provide investors with the means of assessing the impact of regulatory decisions, such as elimination of a fuel adjustment clause, on the variability of a firm's cash flows. In addition, if the regulatory climate data is found to be associated with market measures of risk, the results may enhance the efficient use of available information in risk assessment.

Because firm valuation is linked to a firm's cash flow variability, and thus to its cost of capital, financial managers have a direct interest in this research. Cost of capital estimates are used in investment decision analysis and in determining the allowed return to capital. Rate of return regulation rests upon the determination of a return on equity comparable to earnings on equivalent risk investments. This allows capital to be attracted as needed. If regulatory climate affects a firm's risk profile, then equivalent risk methods for determining equity costs should account for this relationship. If the findings of this research are significant, the information will facilitate improved estimates of expected equity costs and, consequently, better estimates of the firm's cost of capital.

On the policy level, knowledge of the relationship between regulatory climate and perceptions of security risk can serve as an important input to policy decisions. To the extent that differences in regulatory climate arise from differential application of identifiable regulatory policies, knowledge of this relationship can be used to improve evaluation of current or proposed policy changes. Further, if it is the goal of regulators to minimize total costs, their own contributions to capital costs, through their policy choices, should be recognized.

Consistent with the research objectives and conceptual definitions provided in this introduction, details of the research are organized as follows. In Chapter 2, the institutional setting associated with electric utilities is reviewed. This includes a discussion of the goals and process of electric utility regulation in the United States. The theory and nature of risk is discussed in Chapter 3. Here the concept of regulatory risk is explored in detail. Chapter 4 comprises a review of the theoretical literature and previous investigations of the relationship between regulatory climate and electric utility security risk measures. A descriptive cash flow model, developed in Chapter 5 posits a link between regulatory policy, which determines regulatory climate, and measures of security risk. Chapter 6 presents a description of the research method, the results of which are described in Chapter 7. Conclusions and summary are presented in Chapter 8, the final section.

ENDNOTES: INTRODUCTION

1. See Navarro (1983), Dubin and Navarro (1982), and Archer (1979a,b,c).

Chapter 2

INSTITUTIONAL SETTING

Regulation has been the preferred means of resource allocation in many U.S. industries in which the production technology is believed to lead to natural monopoly conditions. In such industries, the producer has the potential and incentive to produce at a price/quantity combination that has undesirable allocative and distributional impacts. Where the industry is "affected with the public interest," that is, provides a critical service or good, government control is often imposed to achieve desired performance goals. This is especially true in the provision of water, electricity, and some aspects of telephone service. Because the interest here is in the electric utility industry, our discussion will focus primarily on the characteristics associated with this industry.

Economic Characteristics

Regulation of an industry is based upon the premise that the industry is a natural monopoly and requires government intervention to ensure a desirable price and output combination. The predominant characteristic of a natural monopoly is the ability of one firm to service a market, over a sizable range of output, at a lower unit cost than two or more firms. For multiple product firms, the sustainability arguments of Baumol, Bailey, and Willig (1977) provide a similar definition, but with respect to provision of a combination of outputs.

Government intervention in the electric utility is justified, in part, by production and consumption characteristics which contribute to the potential for some degree of monopoly power. Substantial investment in plant and equipment is required by the firm if it is to take advantage of economies of scale. This investment requirement acts as a barrier to entry, limiting potential competitors. Contributing to the investment need is the simultaneity of production and consumption arising out of the nonstorable nature of the commodity produced. This further increases the capital investment requirements since it requires that capacity be held in reserve to provide service when demanded. Finally, because few alternative sources of electricity exist, demand is relatively price inelastic in the short run. This latter aspect is aggravated by the necessity for a direct physical connection between consumer and producer [1]. Switching to available alternative energy sources may be prohibitively expensive or even infeasible in a particular situation. In combination, these characteristics increase the potential for the supplier to extract monopoly rents from the consumer.

In the classical model, the profit maximizing monopolist will produce at a price level greater than the competitive firm and provide a smaller output. Under the monopoly model, allocational inefficiencies will result as resources are not efficiently employed. Similarly, distributional impacts may be undesirable if customers are charged monopoly rents. Because of this potential, control mechanisms have been imposed upon the electric utility industry in the form of regulatory commission oversight. In general, efficient resource allocation and limitation of profit are primary objectives of the regulatory bodies. Typically, regulatory commissions attempt to meet these objectives through limitation on entry, control of prices and specification of quality of service.

Legal Basis

The legal foundation of public utility law is rich in history and can be traced through several landmark court cases. Scott (1979) concisely summarizes the legal basis of regulation :

> The legal basis for regulation in the United States derives from the Constitution. Article I, Section 8 of the Constitution gives Congress the authority to "regulate Commerce...among the several states..." Not until the late 1800's, however, did regulation become an important legal question. In a series of decisions beginning with Mun v. Illinois in 1877, the courts attempted to delineate a category of business so affected with the public interest they should be regulated.
> Early attempts at government regulation took three forms: judicial, direct legislative, and local franchise legislation. Due to the inadequacy of each of these three methods, states began establishing commissions to regulate the various businesses in their domain. Commissions proved viable as a means of regulating public utilities and by 1920 more than two thirds of the

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> states had regulatory commissions. All fifty states and the District of Columbia presently have regulatory commissions of one form or another. The present era of regulation originates with the Hope (2) decision which left regulatory commissions relatively free to establish their own standards in determining regulatory policy. Commissions are also permitted, within limits, to innovate and try new techniques in order to cope with changing economic conditions.

In general, three procedures arise out of the legal basis that govern the process of regulation: procedural due process, substantive due process and judicial review. In combination, these procedures require that commission decisions are fair, reasonable and nonconfiscatory. Regulatory decisions can be appealed if it is felt these conditions are violated.

The Process of Regulation

Regulation is an administrative process. It is empowered with the authority to jointly ensure adequate service at minimum cost while providing a reasonable return to suppliers of capital. Public utility regulation occurs at both the state and federal level. In fact, state law predates federal law with respect to regulation of electric utilities. It is at the state level that most of the influence and power over utilities is exercised. State regulatory commissions have the authority to establish rates and prescribe policy.

To accomplish its goals, regulation focuses on the level of prices and the structure of prices, or rate design. The former can be interpreted as an efficiency criterion--to insure that expenses are minimized and returns are not excessive. Rate design reflects who bears the cost of service. Theoretically, rates are designed for each customer class such that the costs of serving the class are just covered. However, questions of subsidization, cost sharing and the necessity to charge above total costs in some situations complicate the issue.

State commissions exert their main influence through approving the level of rates a utility can charge its customers. Essentially, the structure of utility regulation is based upon cost plus pricing. Prices are set to cover costs plus a fair return to capital. This effectively places an upper limit on the utilitys earnings. The relationship between costs and revenues can be expressed as follows:

$$(1) \quad R = f(E,V,D,s)$$

where R = total revenue requirements($)

E = operating expenses, including taxes($)

V = rate base ($)

D = accumulated depreciation($)

s = allowed return on capital(%)

Typically, this relationship is expressed as follows:

$$(2) \quad R = E + (V - D)s$$

As long as the utility can justify its operating expenses, capital investment plans, and required return, these costs are incorporated into the rates charged customers. It is the commission's responsibility to determine the adequacy of proposed expenses and fair return.

Although simple in concept, several areas of contention arise in determining each of the components of the revenue requirement. Despite guidance by the dual standards of fairness and equity, the actual criteria used by a commission to establish a specific component may be complex and/ or ambiguous. In this area, commissions have substantial flexibility in prescribing the basis for costs and accounting policies. For example, depreciation and other tax related cash flows may be flowed through to customers or normalized (3). Automatic adjustment clauses may be implemented to allow a utility to recover costs not included in rates during a period of rising input prices. Rate bases may be determined on the basis of original cost or fair value while equity costs could be predicated on any number of financial valuation models. Underlying the set of policies chosen will be the equity and efficiency criteria considered important by the commission. These criteria will be dictated to a large extent by the economic and political environment in which a commission operates.

Finally, the time it takes to hear and decide a rate case can greatly impact the liquidity and cash generating ability of a utility. Regulation is an administrative process that requires time and judgement to set rates that strike a balance between established objectives. Overworked and underpaid commissions are often faced with a heavy burden of hearings in adverse times. As a result, considerable time can pass between the time a case is filed and subsequently decided. Alternatively, some commissions employ a conscious lag designed to promote efficiency through cost reduction behavior on the part of the utility. Other commissions may work closely with utility management to expedite the hearing process.

Summary

This flexibility in the regulatory process contributes to variability in policy and accounting combinations across regulatory commissions. Consequently, it is reasonable to expect the process of regulation to affect the value and risk of the regulated firm if it impacts the distribution of its cash flow. It is suggested here that regulation may affect these cash flows through the methods and standards of regulation applied, both in determining total revenue requirements and in its responsiveness to changing economic conditions. We examine this linkage more closely in the next section.

ENDNOTES

1. The above discussion is based primarily upon Howe and Rasmussen (1982) and Schmalensee (1979).
2. Federal Power Commission v. Hope Natural Gas Company (1944). See Kahn (1970) or Howe and Rasmussen (1982) for a more detailed discussion.
3. This issue is essentially moot since the enactment of the 1981 Tax Recovery Act which provides the incentive for all regulatory commissions to allow normalization procedures.

Chapter 3

RISK AND REGULATION

The concept of risk is critical to this research. In order to more adequately examine the hypothesized relationship, this chapter discusses the concept of risk and how regulation may affect it. In brief, the definition of risk employed in this research is related to the ability of an economic unit to maintain the value of its invested capital over time. Regulation can affect this value through its impact on the probability, size and timing of cash flows expected by the firm in the future. The first three sections discuss the nature of risk, sources of risk and its measurement. The role of the regulatory process and its effect on risk is the subject of the latter sections.

Risk and Uncertainty

Uncertainty exists when an event's outcome cannot be uniquely specified. Uncertain events have at least two possible outcomes and usually more. The source of uncertainty can be defined relative to the amount of information available to the decision maker. If an individual has enough information to specify what the unique outcome for an event will be, they face certainty. If the available knowledge does not allow a unique specification of the outcome, uncertainty exists.

Risk can be considered a subset of uncertainty. Webster (1974) defines risk as "the chance of injury, damage or loss." Knight(1933) defines risk as situations where objective probabilities can be assigned to the possible outcomes associated with an event. Robison (1983) offers an intuitively satisfying definition of risk. He defines risk as the "class of uncertain events whose outcomes alter the well being of decision makers, either for good or bad"[1]. This is a broader definition than Webster's, focusing on the range of outcomes, not merely the unfavorable ones. This definition also makes sense from an investor's standpoint. Most investments are made under conditions of risk. Unfavorable outcomes will result in capital losses but the prospect of favorable outcomes are necessary to motivate the investment.

It is Morton's (1969) definition of risk that has the most direct relevance to this research. His definition considers risk from a financial standpoint and argues:

> ...that risk is the uncertainty of the power of capital invested in a given business to earn a competitive rate of return and hence to maintain its value.

Further, Morton contends that when risk is defined as the chance of capital impairment, it is related to the possibility of change in both the size and timing of the expected income stream.

The distinction between risk and uncertainty can take many forms, depending upon the perceptions and needs of the

decision maker. Knight's definition of risk is distinguished from his definition of uncertainty by the inability of decision makers, under uncertainty, to assign objective probabilities to outcomes. Once widely accepted, Knight's distinction has been largely dropped from financial and economic theory because of the subjective nature of all information bases from which probabilities are derived. Moreover, Savage's theorem obviates the need for a distinction between risk and uncertainty, as defined by Knight. [2]. In the remainder of this research the terms risk and uncertainty will be used interchangeably, and Morton's definition accepted in principle.

Decision Making Under Risk

Because risky situations exist, the need arises for a theory of how to make choices between risky alternatives. Our ability to measure risk and the willingness to bear risk determines our ability to explain, predict and prescribe behavior and choice under risk. The theory of how to choose between risky alternatives is the heart of decision theory. In essence, ordering risky choices according to preference will depend upon (a) the actual distribution of possible outcomes and (b) the preferences of the individual decision maker. Thus, the choice of desirable investments will depend upon what we assume about the preferences of the individual investor. Different assumptions regarding investor preferences will result in different preferred investment choices.

For example, acceptance of a stochastic dominance decision framework will lead to the same investment choices as a mean-variance framework only under certain conditions. Both frameworks are efficiency criteria which allow the screening of alternative investments into desirable and undesirable groupings. A mean-variance criterion has investors choosing between investment options on the basis of expected return and variance. It assumes investors are risk averse and the probability distributions of the outcomes associated with alternatives are normal.

Stochastic dominance rules are also dependent upon the amount of available information about investors preferences. The classification algorithm is dependent upon restrictions made about an investor's utility function. First degree stochastic dominance assumes only that the utility function of investors is nondecreasing. That is, investors prefer more to less. Second degree stochastic dominance additionally assumes that investors are risk averse. This latter assumption implies that investor utility functions are concave. The assumption of decreasing absolute risk aversion is added by third degree stochastic dominance. Each additional restriction limits the set of desirable investment alternatives. A mean-variance framework is consistent with second degree stochastic dominance r

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when return distributions are normal. That is, under both criterion the same efficient set of investments will be preferred. The same cannot be said when comparing third degree stochastic dominance with a mean variance efficient set. Consequently, our risk measures will be a function of the decision making framework we adopt. Robison (1983, Chapt. 4, pages 9-12) discusses risk efficiency models in detail and provides a comparison of the more widely used models.

In the finance and economic literature a predominant decision making tool is the Expected Utility Hypothesis(EUH). The EUH states that the preferred choice is one which maximizes the expected utility of the decision maker. The utility associated with the outcome will be a function of the investor's preferences, risk attitude and the probability of the outcome. If we assume rational, risk averse and consistent behavior, the expected utility of an alternative is determined by multiplying the utility of the outcome by the probability associated with that outcome. As a result, this approach ties our measures of risk closely to the probability distribution associated with an event or investment.

Probability Theory and Risk

Probability theory is used to describe the nature of relationships under risk. Probabilities represent the analyst's subjectively based beliefs of the likelihood of a

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specific outcome associated with an event. These probabilities are the weights applied to each specific event. When these probabilities are multiplied by the associated outcomes and summed, the result represents what outcome, on average, is expected.

Broadly defined, risk is measured as a function of the probability distribution associated with an event. For an investment, this risk is represented by the probability distribution associated with the investment's possible cash flows. The risk of an investment is represented by the extent to which the actual outcome can vary relative to the expected outcome. If we assume return distributions are normal, then the standard deviation and variance represent alternative measures of total return risk for an individual asset investment. This assumption is particularly appropriate for common stock securities. Empirical evidence using monthly return data supports the normality assumption as reasonable [3].

Risk and Firm Value

Variance in an asset's rate of return measures the extent to which actual returns vary from average returns over time. The greater the dispersion or variation from the mean, the greater the uncertainty of earning the average return. Such risk plays an important role in asset valuation. Asset pricing models link asset valuation to the variability of an asset's cash flows. Consider the single period valuation model:

$$Vo = \frac{(P1 - Po) + D1}{(1 + k)}$$

This model indicates that the present value, Vo, of a security is a function of its net cash flows over the holding period, D1, plus any capital gains associated with the sale of the asset, (P1 - Po), discounted at the rate k. The discount rate represents the required rate of return on the asset. It is comprised of two elements, the risk free rate and the asset's risk premium. Uncertainty, or risk, is a function of both cash flow uncertainties and uncertainties associated with the real risk free rate. The real risk free rate in itself is a function of the opportunities available for real savings and investment. An inflation premium is also incorporated into the riskless rate since investors expect compensation for anticipated inflation. This risk free rate underlies all required returns since investors expect compensation for both expected inflation and time preference.

Sources of Risk

This risk premium on any asset is a function of the asset's cash flow uncertainty. As Farrell (1983) notes, four sources of risk are important in determining the risk premium; business risk, financial risk, interest rate risk and risk of unanticipated inflation. The first two relate

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primarily to factors associated with a firm's product and capital structure choice. Each firm in the market has risk associated with its firm specific choices. The other two sources of risk are, to some extent, common to all firms in the market.

Business Risk. Business risk relates to the uncertainty of cash flows associated with a firm's investment in assets. It can be measured by variability of the firm's operating income (Earnings Before Interest and Taxes). Variability in operating income arises through cash flow variability associated with all phases of production. As a result, it can be related both to factors within the firm's control or external to it. Pricing, sales effort and efficiency of operations are largely within the firms realm of control and are affected by management decisions. Economic and political decisions may also affect a firm's business risk, but are largely beyond the control of management. An example of this is the imposition of safety standards which raise the level of fixed operating costs for all firms in an industry. Other factors contributing to business risk include variability associated with pricing policy, demand, input cost, supply and management efficiency.

From a securities perspective, common stockholders are affected more extensively by business risk than bondholders. The greater the level of fixed operating costs, the greater the uncertainty that expected returns will be

realized. For stockholders, capital losses will occur if actual cash flows are less than anticipated. Bondholders are less affected because the cash flows associated with bonds are fixed. However, the greater the level of fixed operating charges, the greater the default risk potential.

Financial Risk. Financial risk is independent of business risk and results from the addition of debt to the capital structure of the firm. As the level of debt increases, security risk increases for both bond and stockholders. This effect is due to the higher level of fixed interest payments. As the level of debt increases, debt holders face a higher default risk while equity security holders experience greater variances of return. More uncertainty exists as to whether shareholders will earn their expected returns when the level of debt increases.

Interest Rate Risk. Interest rate risk is the return variability associated with changes in the level of interest rates. Because valuation is directly tied to underlying interest rates, all market prices will vary inversely, to some degree, with changes in interest rates. Capital gain returns are affected by changes in interest rates because of the discounting associated with future cash flows. This makes long-term securities more price sensitive than short-term securities when interest rates change. The longer the stream of promised or expected cash flows associated with the security, the greater its sensitivity to changes in interest rates.

Inflation Related Risk. Inflation related risk relates to the return variability associated with unanticipated changes in inflation. Because inflation can not be predicted perfectly, actual returns will not equal expected returns in periods of changing prices. The return variability of fixed income securities is more sensitive to changes in the rate of inflation because only market price can change to compensate for changes in required returns. With flexible return securities such as common stocks, the opportunity to change the cash flows being paid to holders can bring expected returns in line with required returns. Consequently, they may be less subject to purchasing power risk than are bonds or preferred stock. Empirical research has failed to confirm this hypothesized relationship.

In summary, the sources of total return variability reflect both general market-wide phenomena and company specific policies related to the levels of fixed costs and operational efficiency. Capital theory however, is generally concerned with evaluations of the risk/return characteristics of particular securities relative to all other securities in the market. To consider risk in this framework, it is necessary to first discuss the concepts of risk measurement and the relative nature of risk.

Measurement of Risk

As previously indicated, measures of risk are taken directly from the probability distribution associated with an asset's cash flows. Both the standard deviation and variance of returns can be used as alternative measures of total risk. The standard deviation is frequently used when comparing assets, because it represents a variability measure in the original units of measurement. This is more easily interpreted than the variance which is a variability measure recorded in the original units of measurement squared.

Risk of Single Asset Held in Isolation

Investors who invest all of their funds in a single asset bear the total cash flow variability associated with that asset. For example, individuals who placed their entire life savings into Washington Public Power Supply System bonds concentrated all of their return expectations in one asset. In these instances, the standard deviation of return is the appropriate risk measure since it provides information regarding both the upside potential returns and the downside potential losses.

Despite the use of standard deviation as a measure of total risk, it does not reflect the diversification benefits associated with holding a portfolio of different investments when the investor chooses to invest in more than one asset. Most investors hold a relatively diverse group of investments in stocks, bonds, real estate, human capital and other real and financial assets. Such investors are taking advantage of the diversification potential inherent in less than perfectly correlated returns. As long as the correlation is less than one, the total variability of holdings is reduced by combining assets whose return movements do not exactly covary. Thus, when we consider the risk of a single asset relative to an existing portfolio, another measure of risk is necessary. Total variability is no longer relevant.

Risk in a Market Setting

When considering the risk of a single asset relative to a portfolio of assets, the focus is on the contribution of that asset to the total variability of return. In this context, risk is measured relative to the covariance of the assets return with the return on the market.

In a market setting, total return variability can be dichotomized into systematic and unsystematic risk. The systematic risk of an asset is defined as return variability that cannot be diversified away when combining assets into portfolios. It represents the extent to which the assets returns systematically co-vary with the returns of the entire portfolio. The less systematic this covariance, the lower the risk contribution. This is because total return variability can be reduced by combining securities with offsetting return patterns. To measure this relative riskiness the covariance statistic is used:

$$Cov(R_i, R_p) = corr(i,p)\sigma_i\sigma_p$$

where

$Cov(R_i, R_p)$ = the covariance between the returns on security i and portfolio p

$corr(i,p)$ = the correlation between the return movements on security i and portfolio p

$\sigma_{i,p}$ = the standard deviation of security i, the standard deviation of portfolio p

Systematic risk is simply the return variability related to the overall movements of the market. It is measured by the covariance statistic. This risk is a function of social, political and/or economic events that affect the returns of all assets. For example, a change in the level of interest rates or in the rate of inflation will affect all security returns to some extent.

Business and financial risk also underlie systematic risk. Their contribution to systematic risk is a function of the degree to which the risk is one that is shared by all other securities. For example, the systematic portion of business risk can be represented in the following manner:

$$\text{Business risk} = Cov(R_i, R_p)$$
$$= corr(\bar{R}_i, \bar{R}_p)\sigma_i\sigma_p$$

In this representation, R_i represents the return on operating assets of the firm, all the other variables are the same as previously defined. The amount of systematic business risk inherent in any one firm will be a function of the correlation between the firm's return on operating and cash flows, the market's return, as well as the standard deviation associated with each return.

Unsystematic risk is that portion of return variability which is unrelated to the return variability of other securities in the market. Because it is caused by changes in firm specific risk, it is not related to changes in the market. Both business risk and financial risk influence unsystematic risk as well. All factors that are unique to the firm will cause unsystematic return variability. For example, a strike that affected one firm, or one industry would cause cash flow variability that does not affect the returns of all securities in the market, and would be considered unsystematic.

In summary, interest rate, inflation, business and financial risk underlie the return variability of any single security. When considering the risk of a single security held in isolation, the appropriate measure of risk is its total return variability. In a market setting, it is only the systematic variability associated with these risk sources that determine a security's contribution to the risk of a portfolio.

These concepts of risk can be utilized when we consider how regulation of the electric utility industry may affect the security risk of a regulated firm. To the extent that the parameters of the return distribution are affected by regulation, financial theory suggests the risk and value of the regulated firm will be affected as well. Investors' perceptions of risk and return are a function of expected cash flows. If regulatory policy can influence a firm's cash flow, we would expect that it would affect perceived risk and return as well.

REGULATORY EFFECTS ON RISK

The direct link between regulatory policy and cash flow risk has largely been ignored in the academic literature. Instead, attention has been focused on the performance consequences associated with imposing regulation upon an industry and regulating its return. In the classical analysis of the firm, the bulk of the literature that concerns regulation treats it as an exogenous force relative to risk. That is, regulatory models of the firm have traditionally assumed that the discount rate to be used in valuation was not affected by the regulation itself. In a static world with perfect, continuous regulation and informationally efficient capital markets, the regulated firm will earn a market return and customers will receive service at fair and reasonable rates. Regulation in this context does not guarantee a specific return nor does it reduce all uncertainty, but is intended to allow the regulated firm to earn a competitive return on an ex ante basis [4]. Historically, many regulators have assumed this framework was appropriate and did not explicitly consider if or how their actions might affect the firm's return variability and perceptions of security risk. Within the last decade, however, there has been an increasing awareness of the potential impacts that regulation might have on the risk and subsequent capital costs of the regulated firm.

This is because the economy within which a utility operates is not static nor is regulation continuous. Instead, regulation is a discrete process. When costs are changing, the possibility of revenue shortfalls or excesses are more likely if rate changes frequently lag behind cost changes. The response of regulators to eroding cash flows and to changes in the economic environment may have an impact on security risk by affecting cash flow stability and level. If we acknowledge that we are operating within a changing economic and political environment, characterized by imperfect information, the assumption of an exogenous regulatory process needs to be reconsidered.

The link between regulation and investors' perceptions of risk can be made more explicit by first defining regulatory risk and discussing its implications. Subsequently, the impact of regulatory policies on a firm's level and predictability of cash flows can be considered. With this information, inferences regarding investors' perceptions of regulatory climate can be made.

Regulatory Risk - Background

Regulation in the 1950's and early 1960's was essentially a nonbinding constraint on the activities of electric utilities. Price stability and the benefits associated with economies of scale and technological change led to low relative prices for electricity. During this period, utility rates remained stable or fell. Few rate cases were heard during this time, with most being initiated by the commissions. To the extent that costs fell for the utilities but rates remained the same, the utilities experienced an increase in profits until rates were brought in line with costs. That is to say, it appears that regulatory lag worked in the favor of utilities over this period of time.

Inflationary pressures began affecting the electric industry in the late 1960's. Rising input cost levels led to an increased number of rate increase requests. Despite operating price increases of around 4.4 percent over the 1965-1969 period, rate increase percentages were lower. Relative rates of return fell and operating margins declined as a result. MacAvoy (1979) argues that commissions were reluctant to increase rates to fully reflect cost increases for fear of public reaction to the dollar amount involved. In addition, regulatory lag worked against the companies requesting rate increases. Not only did the number of rate increase requests increase significantly in the late 1960's but the average length of time to decide a rate case increased substantially as well [5]. This led to lower relative earnings as the gap between actual costs and actual revenues grew larger.

Significant price increases continued into the 1970's. The regulatory process, faced with an inflationary and recessionary environment, proved to be relatively inflexible to the changing economic conditions. Revenue requests were rarely granted in whole, and regulatory lag intensified as more companies filed for rate increases with increasing frequency [6]. Investor rates of return continued to fall behind allowed returns and allowed rates often reflected returns below capital costs. Commissions continued to resist large rate increases for fear of negative public reaction [7].

It was the inability of the regulatory commissions to adapt well to the changing economic environment that drew the increased attention and concern of the investment community. By the mid-1970's numerous articles were written that lamented the low relative rates of investor returns. These lower returns were often associated with the regulatory environment of the utility involved.[8] The concepts of regulatory climate and regulatory risk were being discussed with increasing frequency [9]. At the same time, the investment community began to rank the regulatory commissions of each state according to how they felt the commission's responses would affect the relative investment climate of the regulated firm operating in a specific jurisdiction.

Specific definitions of regulatory risk and regulatory climate were developed for this research that are based upon the investment community responses. While it is possible to define these terms in a number of ways, the definitions follow the implied definitions as used in the financial press.

Regulatory Risk - Definition

Regulatory risk will be defined as an absolute measure of the perceived impact of regulatory commission policies on a firm's security risk. Conceptually, it is a function of three primary factors:

1. the consistency of the regulatory approach in its use of policy instruments which affect cash flows
2. the level of cash flows over time
3. the impacts on cash flow variability associated with specific regulatory policies

Consequently, regulatory risk is the net result of the combination of these factors. This specific definition is consistent with Morton's general definition of risk discussed earlier (1969). It associates regulatory risk with the influence the regulatory body has on the size, timing and probability of expected cash flows. With respect to regulated utilities, Morton further refines his definition of risk as:

> ...the possibility it (the firm) may not be able to make that adjustment (to changes in costs) as well as its competitors or in a manner that will preserve its profitability and capital value.

The concepts of consistency and level of cash flows, along with regulatory policies, are discussed below.

Consistency. The consistency of regulation relates to the ability to predict the level of expected cash flows. To the extent that a commission is consistent in its philosophy and approach to regulation, cash flows can be predicted with greater accuracy and hence, less risk. Thus, we will assume that a commission will be perceived as employing a less risky policy if it is consistent in its approach, even if it allows returns that are relatively lower, on average, than a commission which frequently changes its philosophy or approach. This is consistent with Brennan and Schwartz's (1982) findings that a consistent regulatory policy implied a higher firm value.

Level of Allowed Earnings. The relative level of the allowed rate of return on stockholders equity can also contribute to regulatory risk. The level of allowed return will impact return variability through its association with consistency and adequacy. As long as a commission allows a utility the opportunity to earn an adequate return, and investors recognize that a commission is consistent in its policy, this aspect of regulatory risk is minimized. Changes in policy that result in an inadequate level of allowed earnings, however, will cause a one-time drop in market value as cash flow expectations are lowered. This will not constitute a change in risk if it is perceived as an isolated one-time change, but will result in a reduction of firm value. A riskier regulatory environment on this basis would be one that was inconsistent in the adequacy of allowed returns. Moreover, if a commission consistently allowed earnings levels that were insufficient to meet actual requirements, the firm would eventually go bankrupt. Expectation of this would produce a risky regulatory environment relative to one in which earnings were low but cash flow adequately assured. A low level of allowed return does not necessarily imply regulatory risk if earnings are sufficient and regulatory policy is consistent. It is inconsistency in the level of allowed earnings and/or earning levels that regularly fail to meet cash flow requirements that produce regulatory risk.

Regulatory Policy. The final component of regulatory risk is the policy instruments that are employed by commissions. Policy instruments are the accounting and control practices that a commission selectively approves. These policy tools will affect how required revenues are calculated as well as the actual level of revenues earned between rate reviews. Most frequently, they include practices that allow a firm's actual revenue stream to more closely approximate actual costs without the formality of a rate review. These practices include the use of automatic adjustment clauses, interim rate relief and choice of the test year on which to determine revenue requirements. Application of these policy instruments can change the level and/or predictability of a firm's cash flows and thus, the level and predictability of security cash flows.

Commissions will differ from state to state with respect to the political environment under which they operate, as well as their philosophy, experience and approach to regulation. Although the legal basis of regulation mandates that regulatory bodies set rates which are not confiscatory nor discriminatory, the commissions retain a great deal of flexibility in choosing the policy instruments and techniques to meet their objectives. The resulting differences in application of these policy instruments have led the investment community to conclude that regulation has a discernible effect on the market for electric utility securities. Some of the more common regulatory policy instruments are described in the following section.

POLICY INSTRUMENTS

Regulatory lag

Regulatory lag occurs because regulation is not a continuous process. This results from the institutional nature of regulation that requires a utility to file a petition for a rate increase only after expenses have risen. As a consequence, delays occur between the time a utility files for a rate increase, after expenses have risen, and when the rate relief is granted. Moreover, rate increases are allowed only when need has been demonstrated. Additional time must pass while the commission investigates and considers the request. Thus, when a rate increase request is filed, hearings are held to determine to what extent the rate increase is justified. Because this is a time consuming and complex process, a lag occurs between the time the request is filed and the case is heard. During this time, the gap between actual revenues and actual expenses widens.

If the regulatory lag is consistent and known, there is no risk associated with the presence of regulatory lag. Firms would simply initiate a rate proceeding n months prior to the point of need, where n is the known regulatory lag. The lag effect will be nullified if the rate case is decided when the firm actually needs the increases. However, it is the uncertainty of the time required to complete a rate case that leads to the risk. The longer the time period, the greater the revenue attrition associated with the lag. In many states, statutory constraints require that a case be decided within a given number of months after a rate increase is filed. While this may mitigate the ultimate length of the institutional lag, the lag itself may be substantially greater than that experienced during more stable periods.

Bailey and Coleman (1971), Wein (1968), Bonbright (1967) and others [10] contend that regulatory lags provide advantages because they give the firm the incentive to operate more efficiently. Bailey and Coleman (1975) show that the use of regulatory lag, in conjunction with an allowed return close to the market return, causes the firm's production choices to be driven to the minimum cost combination.

Another school of thought [11] holds that lags discourage efficiency and progress. They argue that delay dampens the incentive to innovate, distorts resource allocation and encourages the padding of production costs.

Reasonable arguments can be made for both views. Regardless, the most immediate effect of regulatory lag is earnings attrition. Required revenues are not met and the value of the firm is reduced. Efforts to avert earnings attrition have produced the remedies of automatic adjustment clauses, interim rate relief and the use of future test years in periods of rising costs.

Automatic Adjustment Clauses

Automatic adjustment clauses (AAC) were introduced to mitigate the impact of rapidly rising prices and regulatory lag. While primarily limited to fuel costs, AAC's have been applied to labor, other expenses and the return on equity. AAC's have their primary effect on specific cost elements beyond regulatory or firm control for which it is judged "fair" to automatically pass through increases. A well designed AAC will help a firm maintain its rate of return by reducing the effects of regulatory lag, protecting consumers in periods of declining costs and easing the time and cost burden of frequent rate cases. As a result, it should help maintain the firm's ability to attract capital as needed [12]. Clark (1980) found that automatic fuel adjustment clauses (FAC's) designed to hold expected profit constant have the effect of decreasing systematic risk. He presents evidence that indicates large utilities with full FAC's in place during 1970-1974 experienced a decline in systematic risk of approximately 10 percent. Risk is reduced in that the expected profit level does not change, but the distribution of outcomes becomes tighter.

The major objection to automatic adjustment clauses is that they reduce the firm's incentives to be efficient in factor use and contract negotiation. This is because the risk of changing input costs is shifted from stockholders to consumers when automatic adjustment clauses are in place.

Interim Rate Relief

In many cases, a commission will allow utilities to put into effect part or all of a proposed rate increase before the rate case is completed. Such increases allow companies to increase cash flow over the rate review period and ease pressures stemming from increased costs. If the rates resulting from conclusion of the rate case are lower than those in effect over the interim, the difference is refunded to the consumers. To the extent that additional cash flow is provided to the utility during the rate hearing process, interim rate relief is beneficial to the firm.

Test Year Basis

The revenue requirements associated with a proposed rate increase are determined by examining the cost and results of operation for a given period of time. This period of time is designated as the "test period" for determining allowable revenues and expenses for future rates. In general, the test period a utility selects is one of the following three alternatives: (1) historical average test year, where the most recent twelve months of data are utilized for determining revenue requirements, (2) year-end test year, where rates are based upon information obtained for a recent point in time, and (3) forward test year, where a projection of revenues, expenses and investment is employed as the basis for computing revenue requirements. Many utilities employ a combination of the above three approaches when determining revenue requirements.

Rates based upon a projected test year are more likely to reflect actual costs of service in periods of changing prices than those based upon historical information. Use of a forward based test year lessons the gap between allowed revenues and actual revenues in periods of rising input prices. Historical test years are more reflective of expected costs when prices have been relatively stable and are expected to remain so. Year-end test years are an intermediate case, in terms of cash flow effects, relative to the other approaches. In states where statutory requirements designate the use of a particular test year method, this policy tool is out of the hands of both regulators and the firm. The basis of the test year, from any source, will contribute to the overall regulatory climate in a jurisdiction.

Allowed Rate of Return

In theory, the allowed rate of return equals the company's cost of capital. This cost of capital is included in the rates set by the commission, which reflect an allowance for all expenses. A commission must determine allowable rates for debt, preferred stock, and equity capital, which represent the major sources of funding for a utility. In practice, determining the cost of debt and preferred stock is not a difficult task since the allowed rates of return reflect embedded costs. As a result, the costs of outstanding debt interest and preferred stock dividends reflect the relevant allowable cost.

It is in determining the allowable equity costs that the potential for regulatory risk arises. There are several methods of arriving at equity costs. In general, the most common methods include the application of a discounted cash flow model, a risk premium applied to market debt returns and a historical earnings approach. However, there is no one method that is universally accepted, although the discounted cash flow model is most frequently used.

In determining the cost of equity, it is common to identify a group of similar-risk firms and then estimate the cost of equity for the group by applying one of the standard methods. The result is then used as an equity return guideline for the case at hand. Unfortunately, there is no unambiguous method for determining equal risk among firms. Even using the electric utility industry as an equal risk industry may be inaccurate. Evidence presented by Boness and Frankfurter (1979) indicates that the industry exhibited considerable heterogenity with respect to estimates of cost of capital, and thus, risk. That is, significant differences between firms in the industry were noted for the estimates of coefficients and variance associated with the cost of capital model.

Regulatory risk is linked to this aspect of regulation through the influence the commission has on allowing what equity methods are acceptable, which companies can be considered similar risk and the general attitude towards the level of the allowed return. In the 1970s, evidence suggests that utility commissions allowed rates of return that were consistently less than market rates, and/or utilities earned consistently less than market rates of return. Whether these results were related to bias in determining equity costs and equal-risk firms, regulatory lag or utility inefficiency is not easily discernible. In such a climate, the higher the allowed rate of return on a relative basis, the higher the level of a utility's expected earnings. To the extent that a commission allows a relatively high rate of return, a utility is more likely to meet its revenue requirements, especially in a period of fluctuating prices. As a result of allowing equity returns in the high end of an estimated range, regulatory risk can be lowered.

Normalization vs Flow-Through of Tax Related Policies

Two general methods of depreciation are available to a business. Straightline depreciation allocates the cost of an asset in equal increments over its life. Accelerated depreciation provides for a greater depreciation expense in the early years of an assets life, relative to straightline, and lower depreciation expense in the later years. Since a firm can only recover the original cost of an asset, the total depreciation charge, and thus taxes, under both methods are identical.

Accelerated depreciation affects the timing of tax payments. Under accelerated depreciation, depreciation expense is greater in the early years, taxable income is lower and thus the taxes paid are lower. In later years, with a lower depreciation expense, taxable income will be relatively higher, and the taxes paid will be greater. This more rapid recovery of costs in the early years of an assets life results in a tax timing benefit. That is, the present value of the recovered depreciation cash flows under accelerated depreciation is greater than that under straightline depreciation.

The tax timing difference associated with accelerated depreciation has generally been allocated in one of two ways. Under normalization accounting methods, the tax timing difference is treated as a tax deferral. The taxes allowed in the expense calculation on the books are those that would have occurred using straightline depreciation. A deferred tax reserve is created on the liability side of the balance sheet to credit the difference between taxes paid under accelerated depreciation and under straightline depreciation. As a result, reported operating costs are what they would have been with straightline methods, and the utility's short run cash flow is increased relative to straightline depreciation. In general, a utility is not allowed to earn a return on the tax reserve amount. The fund represents customer-contributed capital, for which a return is not considered appropriate. Instead, the reserve is deducted from the rate base or included in the cost of capital at zero cost.

Flow-through accounting requires that the actual taxes paid in each period be reflected in the revenue requirements of the firm. In this case, current customers benefit, through current lower rates. Operating income is decreased as tax reductions are flowed through to income and cost of service falls. This approach considers the legitimate treatment of taxes is to record only the actual taxes paid. Under flow-through, future customers will face higher taxes if the level of utility investment falls.

From a financial standpoint, normalization allows for better utility cash flow and a corresponding strengthening of coverage ratios. In addition, it provides a zero cost source of capital. Essentially, the tax deferral associated with accelerated depreciation represents an interest free loan to a firm, arising from the tax timing difference associated with tax payments. If a firm continues to invest and grow, the increased cash flow and lower tax bill associated with the early years of accelerated depreciation will become permanent. O'Donnell (1965, 1968) provides a more complete discussion of this issue, although he concludes that both stockholders and ratepayers are injured by the flow-through method of treating accelerated depreciation.

The issue of normalization vs flow-through policies has essentially been rendered moot by the Economic Recovery Act of 1981. The Act requires all public utilities to adopt normalization techniques if they wish to be eligible for federal tax benefits. However, to the extent that pre-1981 data is used in this research, the differential allowance of these techniques of reporting business income by commissions will be reflected in the regulatory rankings of state commissions.

Investment tax credits represent a permanent reduction in taxes arising from a given percentage of new investment. As required by the U.S. Revenue Act of 1971, investment tax credits are shared between the utility and the customer for those firms electing to take advantage of the credit. The tax savings are normalized and returned to customers over the life of the asset. The plant associated with the investment tax credit is included in the rate base and thus a return is earned on the investment. This procedure increases cash flow to the utility relative to flow-through accounting.

Treatment of Construction Work in Progress

The revenue requirement associated with the cost of securing capital for the utility is determined by the product of the after tax cost of capital and the utility's rate base. The utility's rate base is defined as the physical plant and working capital committed to production, which is used and useful. This rate base may or may not equal the capital supplied on the books.

In determining a rate base, regulators must determine the appropriate components that represent invested capital. The rate base is primarily composed of investment in utility plant in service, working capital and plant held for future use. Whether to include construction work in progress into the rate base has been a problem for regulators. Although the plant under construction is not used and useful, it does represent a significant investment for which a return is allowed. Utility plant under construction has been treated in one of two ways for rate making purposes.

Historically, plant under construction was not always included in the rate base because it did not represent a significant part of total investment that was used and useful. Any financing costs associated with a construction program were capitalized. An Allowance for Funds Used During Construction (AFUDC), is allowed as an income credit for interest costs on debt and a reasonable return on equity funds devoted to a plant under construction. Such funds do not reflect actual cash, but only a credit to the plant's expense account. Cash flow is not increased since AFUDC is only a bookkeeping entry, yet reported net earnings and coverages ratios increase. Consequently, the quality of reported net earnings decline. In recognition of these lower quality earnings, current industry practices exclude AFUDC income in calculating coverage ratios. Reported net income and coverage ratios are increased, not case flow. The AFUDC charges are accumulated through the construction period and added to the investment base of the utility plant when the plant becomes operational. These capitalized expenses are recovered through the higher book depreciation charges related to the higher investment base.

Conditions in the utility industry in the 1970s led to substantial investment in construction programs. As a result, AFUDC income became an increasingly significant portion of reported net income. In 1970, AFUDC represented 20 percent of reported net income for the utility industry in general. By 1982 the Edison Electric Institute estimated it would represent some 46.9 percent of net income for the average utility. For some utilities, AFUDC represents 70 percent of reported net income. This trend has led many to argue for allowing construction work in progress in the rate base.

Construction Work in Progress (CWIP) accounting allows all or some of the dollars spent on current construction programs to be placed in the rate base. A return is earned on the amount, thus, current revenues are provided on the investment and the firm's liquidity is increased. Accordingly, companys generally prefer CWIP accounting be adopted because it increases current cash flow and tends to reduce the risk of investment.

Since AFUDC income is a book entry and represents deferred cash flow, many financial analysts contend that AFUDC income is more risky than income derived from operations. This is especially true in light of canceled construction programs and uncertainty about allowing unfinished plants in the rate base [13]. The notion of risk related to AFUDC has two dimensions. The first relates to investors' concern with cash flow, not book earnings. Because AFUDC represents a claim on future earnings, and is not a cash flow, the question of ability to pay dividends and provide for investment cash flows is raised, especially where AFUDC represents a large component of reported income. In addition, the question arises of whether or not AFUDC income is more variable than operating income, and hence, more risky. The empirical evidence is contradictory with respect to the riskiness of AFUDC income, but does suggest that such earnings are more risky relative to operating income.[14] Bowen (1981) found that while AFUDC earnings were positively valued, they were not as highly valued as a dollar of operating income. He argues this result stems from concerns about future inflation, demand, technology and regulatory climate that combine to make AFUDC earnings more risky. Further detailed discussion of the AFUDC issue is provided by Ifflander (1982).

The Relationship Between Regulatory Policy Instruments and Risk

The components of regulatory risk and the subsequent hypothesized impact on firm value and risk measures are summarized in Table 3.1. In general, these components affect either the level or variance of expected shareholder earnings. In the case where variance is affected, we assume risk changes of the nature associated with a mean preserving spread. Under this assumption, when a policy change occurs that affects the pattern of cash flows, it is assumed that earnings are redistributed into a more (less) valued pattern while keeping the expected level of cash flows the same. That is to say, the standard deviation of the distribution is reduced while the expected value remains constant. For example, in the case of an increase in the pass-through allowance of an AAC, the spread of the distribution would become tighter as the tails of the distribution are lightened. This allows expected returns to remain at the regulated level while the probability distribution of returns is affected by regulatory policy.

Table 3.1 Hypothesized Impact of Regulatory Risk Components on Firm Risk and Return Characteristics

Component	Direction of Change	Impact of Policy Use on: E(CF)	Var(CF)	Beta	Value
Consistency	+	0	-	-	+
Adequacy of Allowed Return	+	+	0	0	+
Regulatory Lag*	-	0	-	-	+
Interim Rate Relief	+	+/0	0/-	0/-	+
Test Year Basis	to future	0	-	-	+
Normalization	+	+	0	0	+
To CWIP	+	+/0	-	-	+

* under conditions of inflation

REGULATORY CLIMATE

So far in this discussion, regulatory risk has been defined as an absolute measure of the impact that regulation has on the perceived risk of a utility's cash flow available to equity holders. However, while regulatory risk may be defined in a conceptual sense, it can only be measured in a relative sense. In this research, regulatory climate will serve as a surrogate for regulatory risk. Regulatory climate, or regime, is defined as a relative measure of how a commission's policy affects the perceived level and predictability of the security cash flows of a utility. It is expected that the correlation between regulatory risk, if it could be measured, and regulatory climate would be close to 1. Accordingly, it is also expected that those firms classified as conducting business in an unfavorable regulatory environment would have a higher level of risk, ceteris paribus, relative to those firms operating in a very favorable climate. Hereafter, the term regulatory climate will be used exclusively since its measurement is employed to derive relative degrees of regulatory risk.

Regulatory Climate and Regulatory Rankings

The changing economic environment of the early 1970's and the sluggishness of the regulatory response convinced many commissions and utility managers to devise control mechanisms that could more readily respond to these changes. The several regulatory methods just discussed may have an impact on cash flow variability. In many jurisdictions they were introduced to allow a more rapid response to changes in cash costs, or to increase the probability of earning the allowed revenue requirement.

Other commissions resisted such controls, arguing that they reduced efficiency incentives and that rate payers would be forced to assume a disproportionate share of the firm's risk. Such commissions generally favored policies that limited a firm's responsiveness to unexpected changes in the economic environment. The rationale for this type of policy centered around the efficiency incentives provided by greater than anticipated costs [15].

Many of these policy instruments have been shown to affect the variance of the firm's cash flow [16]. In addition, these instruments and their use have been reflected in investment house rankings which evaluate the investment climate within which a particular utility operates [17]. Dubin and Navarro (1981) conclude that the 20 or more services performing these evaluations are highly consistent in the policy variables they use to assess a regulatory climate. In their own study, they use an aggregation of regulatory rankings to classify state commissions according to whether they provide a "very favorable," "favorable," or "unfavorable" regulatory climate. A very favorable rank would imply the use of all or most of the following policy instruments:

-interim rate relief during the rate review process
-allowance of Construction Work In Progress (CWIP)
-current or future test year from which to determine allowed expenses
-normalization of cash flows associated with depreciation and investment tax credits
-relatively high allowed rates of return to equity
-automatic adjustment clause(s)

Such policy instruments create a favorable investment climate because they speed up the inflow of cash to the utility when costs are changing (interim rate relief, automatic adjustment clauses, prospective test year), or increase the probability that it will earn the allowed revenues (CWIP, higher allowed return, prospective test year). The level of expected cash flow is affected in the sense that the present value of the cash flows is greater the earlier they are received. Therefore, mechanisms such as interim rate relief which allows the utility to increase rates provisionally during the rate review process, are more valuable than if the utility were to receive the same rate increase at a later date when the rate case is concluded.

An unfavorable regulatory climate would be characterized by a combination of the following policy instruments:

-little or no interim rate relief
-use of allowance for funds used during construction
-rigid or no automatic adjustment clause(s)
-historical test year to determine allowed expenses
-relatively low allowed rate of return

Such policy instruments are considered unfavorable because they tend to ignore the problems of attrition and regulatory lag associated with periods of rising prices and insufficient revenues.

The middle classification, "favorable," would employ some, but not all, of the policy instruments associated with the favorable ranking and might have one or two characteristics of the unfavorable classification.

Regulatory Climate and Risk Measures

In an earlier section, risk was dichotomized into systematic and unsystematic components. Regulatory risk can be treated in the same way. It would be expected to affect the systematic risk of the utility if it affected systematic return variability. Thus, if regulation guaranteed security returns under all conditions, there would be no tendency for the security cash flows to move systematically with the market, and the utility would have no systematic risk.

If instead, regulation employed policies that increased the overall level of return variability, systematic risk would increase. This can be seen by considering the cash flow impact of deleting an automatic fuel adjustment clause. Cash flows would no longer be insulated from changes in fuel prices, which are highly correlated with changes in inflation, and one would expect systematic risk to increase.

Similarly, one could argue that regulatory policy has its greatest impact upon the business risk of the firm. It is changes in input costs and the level of demand that the majority of the policy instruments address. Financial risk is affected to the extent that capital structure choice may be determined by the regulatory agency.

Summary

It seems reasonable at this point to suggest that the regulatory process affects the parameters of the security return distribution by:

-changing the dispersion of the distribution through the policies it employs. Policies that reduce the dispersion reduce the uncertainty of earning close to the allowed return.

-truncating both tails of the probability distribution. The lower tail is truncated because it is unlikely that a regulated utility would declare bankruptcy, except in extreme cases, given the high costs of reorganization. The upper tail is affected because the highest returns investors expect to earn are limited to the allowed return. Tests of normality indicate the truncation is not significant for the period under study.

The following points may help to clarify these concepts:

-Recognition of truncation points by investors will affect how expectations about earnings probability and required return are formed. Investors perceive an upper bound on their earnings since the firm's actual return is constrained to be no higher than the allowed return set by the regulatory authority. On the downside, a lower bound may be perceived as well. This arises from the expectation that utilities have traditionally had less bankruptcy risk than unregulated firms.

-Regulation changes the ability of the firm to react to changes in costs. This is because of the aspect of regulatory lag - changes in costs are not reflected automatically since rate hearings are required first to ascertain the appropriateness of the requested changes. Lags of one to one and a half years were not uncommon in the mid to late 1970's. The smaller the regulatory lag, the more responsive the firm can be to cost changes and the higher the probability of earning the allowed return.

-Regulatory policies that increase the responsiveness of the firm's cash flow to changes in the economic conditions under which the firm operates can be hypothesized to increase the probability that the allowed return will be earned. Such policies include interim rate increases, use of a forward test year and automatic adjustment clauses.

-The regulatory instruments that a commission has at its disposal and the philosophy of the commission will affect the probability and/or variability of a regulated firm earning its allowed return. Some commissions will choose a bundle of instruments that make it difficult for the firm to respond to a changing environment, yet encourage efficiency; others will prefer a combination that allows more flexibility. To the extent that investors perceive differences in regulatory philosophy and value the commissions differentially, the risk/return relationship of the firms will be affected.

-The actual method chosen by the regulatory body to determine the allowed rate of return on equity may also affect the firm's probability distribution, that is, how close the allowed return is to the required market return. It will be assumed that this aspect of commission policy will be reflected in the regulatory rank assigned by the investment community.

-Finally, the question of efficiency incentives within the regulatory environment and the firm's responses to regulatory tools, from an efficiency standpoint, will be ignored. Any comparison between efficiency, regulatory policy and the risk profile of the utility is beyond the scope of this research.

In the empirical part of this research regulatory climate rankings are used as a surrogate for regulatory risk. Both regulatory climate and regulatory risk have been defined to measure the perceived predictability and level of expected utility cash flows; the former measurement occurs on a relative basis and the latter on an absolute. Regulatory policies are closely tied to the relative regulatory climate of the jurisdiction in which a utility operates. It is argued here that it is the differential application of these policy tools that underlies differences in investment house rankings of regulatory climate. This research provides evidence about the significant differences in regulatory climate and how they impact the risk profiles of electric utilities.

ENDNOTES

1. Robison [1983], chapter 1, page 3.

2. See Savage [1954]. In essence, Savage states that under minimal consistency conditions, if a decision maker can order risk alternatives according to preference, then there exists an underlying weight function that corresponds to the properties of a probability measure. This amounts to an implicit assignment of probabilities even though the decision maker cannot explicitly assign weights.

3. For example, Fama [1976].

4. Per the criterion set forth in Hope Natural Gas Company vs. the Federal Power Commission [1944] and Bluefield Waterworks and Improvement Company vs. Public Service Commission [1922].

5. Statistical Yearbook of the Electric Utility Industry, Edison Electric Institute, various years.

6. Statistical Yearbook of the Electric Utility Industry, Edison Electric Institute, various years.

7. See MacAvoy [1979].

8. For example, see Weidenbaum [1974], Joskow and MacAvoy [1975] and Backman and Kirsten [1974].

9. For example, see above references and Trout [1979] and Archer [1979].

10. See also Scott [1979], Bawa and Sibley [1980], Cowing and Stevenson [1982] and Kahn [1970].

11. See Kahn [1970] and Phillips [1969].

12. To fulfill the criterion put forth in the Hope Natural Gas Company vs. the Federal Power Commission [1944] for establishing a fair return on equity.

13. For example, see Bowen [1981] and Fitzpatrick and Stizel [1978].

14. See Bowen [1981] and Fitzpatrick and Stizel [1978].

15. See Kahn [1970], Archer [1979], Dietrich and Backerman [1983], Trout [1979] and Weidenbaum [1974].

16. For example, see Fitzpatrick and Stizel [1978], Bailey and Coleman [1975], Wein [1968], Kendrick [1975], Scott [1979], Crew [1982], Brennan and Schwartz [1982], Weidenbaum [1974], Trout [1979] and Bawa and Sibley [1980].

17. For example, see "Utility Industry Quarterly Regulatory Report," September 1983, published by Merrill Lynch, Pierce, Fenner and Smith. Similar reports are published by Goldman Sachs and Co., Argus Research and Soloman Brothers.

Chapter 4

LITERATURE REVIEW

The issues associated with regulation have been the focus of extensive research by both the financial and economic theorists. Despite this attention, few studies have directly addressed the problem of regulatory policy and its potential effects on risk. Only in recent years has this trend shifted. This review of related literature is divided into five sections. An introduction comments on the treatment of regulation by economists. The link between the cost of capital and risk is described in the second section, which discusses cost of capital measurement in the utility industry. Section three reviews the treatment by the financial press of regulatory risk concepts. A review of empirical studies directly addressing the issue of regulatory climate is presented in section four. The final section summarizes the chapter.

Introduction

The regulated firm has been analyzed extensively since the publication of Averch and Johnson's pioneering work in 1962. Not surprisingly, the focus of the economic and financial literature has been distinctly different. In their early works [1] economists addressed problems of optimal input choice and the correct pricing decision for the regulated monopolist. Comparative statics and an assumption of certainty were the dominant tools of analysis. Later, probabilistic microeconomics was increasingly employed to analyze input choice and pricing in the context of a stochastic setting [2]. Regulation was most frequently expressed through a rate of return constraint on the objective function of the firm [3]. However, many works ignored the revenue constraint altogether, assuming instead that regulation was represented by a constraint to satisfy all demand, as demanded, and to price at the competitive level [4].

While the economic literature addressed questions of optimal pricing and investment policies, the financial literature approached questions of valuation and required returns to capital. For regulated utilities, the cost of capital literature includes the discussion of risk and return characteristics of comparable firms. A comparable earnings standard dictates that allowed rates of return reflect the return on similar-risk firms. Such an approach allows estimation of the required market rate of return that will provide a market, risk justified rate of return to capital holders. If this rate is earned, the firm can attract additional capital as needed. The three major cost of capital models used in regulation will be discussed in the section that follows.

Cost of Capital Models

While there are several models available for equity valuation and risk estimation, the discounted cash flow model and the risk premium approach are most frequently employed in the electric utility industry. The discounted cash flow model (DCF) was developed by John Burr Williams (1937), with subsequent refinement and popularization by Myron Gordon (1963). Modigliani and Miller (1958, 1966) also proposed a DCF based equity model that is often used.

Valuation under these specifications depend upon expected earnings, expected investment, growth and duration of growth. Makhija and Thompson (1984) compared five valuation models that had been developed specifically for the electric utility industry and which used a discounted cash flow approach (DCF) [5]. They found that differences in the models revolved around diverse assumptions regarding the variables and the specification of which variables were exogenous. Despite these differences, they concluded that all the models explained about the same proportion of variation and that no model by itself was consistently superior to any of the others.

The risk premium approach is based upon the concept that common equity is riskier than debt. The required rate of return on equity is determined by estimating the current cost of debt and adding an equity risk premium. Typically, implementation of this technique requires estimation of an average of current debt costs for similar-risk firms, along with estimates of the historical spread between debt and equity returns.

While intuitive in concept, and widely used, several problems are inherent in this approach. Designation of similar-risk firms can be problematical, as is the estimation of the appropriate time period to use for estimating the historical spread. This problem is particularly relevant if current market conditions are changing. In this situation, the historical spread may not be reflective of expected required rates of return.

The capital asset pricing model (CAPM) is also used for cost of equity estimation although it is not widely accepted in utility rate hearings. This technique allows the estimation of equity return as a function of market risk but is theoretically more difficult to explain and apply. Moreover, problems with implementing the model have limited its acceptance. As a result, its acceptance in utility rate hearings has been slow, although it is increasingly applied.

Although the DCF and risk-premium approaches are utilized because of general acceptance by regulators and expert witnesses alike, they can yield estimates of the cost of equity capital that vary widely. Different assumptions by the analysts account for these varying estimates. The same is true of the CAPM. As a result, the decision process of the commissioners is much more complex and difficult when charged with the task of determining "the" required return on equity capital.

Another complicating factor in equity cost estimation is that regulators are using the standard of comparable earnings when applying these equity valuation models. That is, a determination of required return is made upon the basis of estimating the required return to firms in the same risk class. The resulting estimate for the risk class is then used as the proxy for the required return of the specific utility. Unfortunately, definitions of risk class are not consistent across regulators, and the cost of capital estimates will thus vary according to the basis of comparability.

A potential problem in the application of the equity estimation models is that regulators and utility analysts are assuming the electric utility industry represents a homogeneous risk class industry. Miller and Modigliani first employed the risk class notion in their classic 1958 article when they classified the electric utility industry as having homogeneous risk. Since then, it has often been assumed that firms in the electric utility industry are of the same risk class. This ad hoc categorization of risk has been adopted by many researchers without much question. Yet estimates of equity costs will be biased if the grouping of firms used as a risk class is actually a heterogeneous group.

Few models have been proposed for valuing utility equity returns that explicitly allow for differences in risk class when applied to a group. Litzenberg and Rao (1973) allow for unequal firm specific risk, but then assume away the problem by specifying that the marginal responsiveness to the market is common to all firms in the industry. Thompson (1982) suggests using a random coefficients approach to modeling equity risk. Such an approach eliminates the need for a risk class specification and estimates the cost of equity for individual firms. Alternatively, he also argues that estimating individual cost of equity through times series analysis has potential (Thompson 1984). However, both approaches require a sophistication and training that may not be available to all commission staffs in utility rate hearings.

Despite this attention given the regulated firm, little work has been done that considers the nature of the regulatory influence on valuation or capital costs. In particular, few studies have considered the possibility of a heterogeneous risk class structure for the utility industry that might arise from differences in regulatory environment. Empirical evidence by Boness and Frankfurter (1977) indicates that the utility industry cannot be classified as homogeneous in risk. They find evidence of a substantial lack of equal variance across utility firms and argue that this will bias coefficient estimates of valuation models if not corrected for. If this is true, the source of the heterogeneity across utilities is of interest. One factor that might contribute to this differentiation is regulatory climate.

Regulatory Climate - Financial Press

Arguments and discussions found in the popular press often cite regulatory risk, or climate, as a determinant of investment value [6]. "Regulatory climate" is a term used to describe the relative nature of regulation within a particular state commission jurisdiction. Specifically, it is contended that a firm operating in a jurisdiction where the regulatory body follows policies that favor a utility's cash flows is in a favorable regulatory climate. If the regulatory authority encourages the uses of policies that reduce the probability of meeting revenue requirements, the environment is labeled as unfavorable. Similar designations of regulatory climate are also made by investment houses and large banking firms. The express purpose of such a designation is to provide information regarding differential utility characteristics that may impact the investment decision [7]. For example, Weidenbaum (1974) asserts that it is variations in regulatory practices that cause differential utility returns. He concludes that adopting the concepts and approaches of the most liberal commissions will alleviate the industry's financial pressures. Lerner (1982) contends that utilities operating in a favorable regulatory climate have higher returns on equity than otherwise. However, neither author offers anything but conjecture to support their contentions.

Regulatory climate has often been mentioned in the academic and financial press as a possible determinant of a firm's cost of capital. The argument is made that an unfavorable climate implies a riskier return, and thus a higher required return [8]. Unfortunately, this argument has not been developed analytically nor has the empirical link between regulatory climate and cost of capital been well established. As Delano and Howard (1973) point out:

> The problem of regulatory climate or strictness is mentioned frequently in the financial literature, both in textbooks and journals dealing with investments in public utilities... Such discussions however, proceed in a rather vague manner. The fact that regulatory climate is important is summarily acknowledged, possible effects are mentioned in general terms, and after the investor is told how the topic is important, little is said about how an unfavorable regulatory climate is defined.

Increasingly though, it is realized that regulation may impact expected returns through the policy instruments it employs. Myers (1972) notes that:

> ...the regulatory process introduces an element of uncertainty which makes it difficult to access the investor's expectations, and thereby makes it difficult to measure the cost of capital.

Melicher (1976) suggests that regulation increases investor risk as long as regulators "systematically attempt to prohibit excess profits." He concludes that compensation for regulatory policy may be a required part of the return component. Brigham and Crum (1975) postulate that this regulatory risk is attributable, in part, to the political climate being more receptive over the past decades to utilities earning less, rather than more, than their costs of capital. Finally, as Brennan and Schwartz (1982) point out:

> ...since the regulator's decisions affect the prospective rate of return on new investment, they have implications for the efficiency of capital allocation within the economy. Moreover, since the regulator's decisions affect the returns to the residual claimants on the utility, its shareholders, regulatory policy is one of the determinants of the value of the shares of the utility and of the risk borne by the shareholders. The other determinant being the stochastic properties of the cost and revenue stream to which the utility is exposed.

In summary, we are dealing with a concept, which while widely acknowledged, is elusive in both nature and definition. The purpose of the next section will be to examine more closely those studies that concern themselves specifically with regulatory climate and the development of theoretical models incorporating regulatory climate.

Regulation and Regulatory Climate - Empirical Studies

Delano and Howard (1973) prepared one of the first studies that explicitly addressed regulatory climate. In their research, they attempt to assess the effect of regulatory climate upon investor performance and cost of equity capital. Two measures of regulatory climate were employed in their study. The first measure of risk was a composite ranking developed by three professionals who had been asked to rank utility climates. The second measure utilized was the difference between market and book values of equity. The rationale for this latter measure was that a wide positive divergence implied a more liberal regulatory climate and thus, greater returns and market value. Spearman rank correlation coefficients were used to relate each ordinal measure with three different return measures - cost of equity, return on net plant, and return on book value of investment. The results of the study suggest that there is no support for the argument that regulatory climate is associated with either rate of return to investors or the cost of equity capital. Several factors may have contributed to this result, however. The return measures are historical, representing past performance and costs of capital. The rankings by the professionals were expectational and forward looking. Differences between these two perspectives could lead to these results. In addition, the assumption that market to book (M/B) differentials are the result of regulation only is questionable. M/B ratios are affected by a number of factors, of which regulation is only one.

Trout (1979) employed a multiple regression model to estimate the impact that regulation might have on the M/B ratio of the firm and consequently, its cost of equity. The M/B ratio was hypothesized to be affected by return variables, company variables, and regulatory variables. The return variables included the expected return on equity and the return on average equity. The company variables Trout chose were leverage, growth, payout ratio, percent electric revenues, and cost of power sold. The regulatory variables specified were the ratio of AFUDC to net income, deferred taxes to total cash flow and a regulatory dummy variable.

Three regression models were tested, each with different combinations of regulatory variables. When the dummy variables for climate were excluded, the coefficient for each regulatory variable considered separately was significant and of the expected sign. Two conclusions were suggested by Trout. First, firms which are allowed normalization policies have higher prices . Second, capitalized construction costs (AFUDC) are associated with lower stock prices. When all regulatory variables were included, only the normalization coefficient was not statistically significant. On this basis, Trout concluded that regulatory climate and AFUDC income were important determinants of the M/B ratio, but normalization policy was not.

Trout further estimated how the cost of equity was affected by changes in regulatory climate. An elasticity framework, and an assumption that the M/B ratio is 1.00

when required returns equal actual returns, was utilized to relate market returns to book returns. Trout argues on the basis of his model that changing from a below average regulatory climate to an average regulatory climate would reduce the cost of equity capital by .69 percentage points. Similarly, moving from an average climate to a favorable climate is estimated to reduce the cost of equity by 1.28 percentage points.

While Trout's results are supportive of a significant relationship between regulatory climate and value, some problems of methodology exist in his analysis. His specification of the regulatory dummy variables allow only for a linear relationship among different regulatory policies, when in fact the relationships may be nonlinear. Moreover, the assumption of a model where the M/B = 1.0 when required returns are equal to actual, while theoretically supportable, is questionable when applied to actual data. Utilities can earn more or less than nominally allowed returns when regulatory lag exists, when input costs are different in the actual period relative to the test period, when the vintage of generating plant increase over time, when profits from nonregulated activities are part of the book return, or when accounting differences do not reflect economic value. Application of this method to an actual case would not be appropriate unless these factors could be accounted for. Moreover, the author's specification of regulatory climate includes only a few of the policy tools available to a commission. This omission may lead to misspecification bias in the results. Finally, because Trout's model does not rely upon a theoretical model, it does not give us insight into the underlying determinants of the observed relationships.

Archer (1979,1981) has also empirically examined the relationship between the cost components of a utility's capital and regulatory climate. He related capital costs to regulatory climate in a simple univariate regression model, where the cost of a capital component was the dependent variable and the average regulatory rank was the independent variable.

Not surprisingly, Archer found the relationship between component cost and regulatory rank to be statistically significant for all sources of capital as well as the weighted average cost of capital. He concludes that capital costs are strongly related to ratings that reflect the stringency with which individual states regulate rates. Unfortunately, with regulatory climate as the only independent variable, the potential for misspecifying the relationship is great. Thus, while regression coefficients were statistically significant, the coefficient of determination (R2) was low for each regression result. It is difficult to make any strong conclusions on the basis of these results. All one can say is that a correlation exists between cost components and regulatory climate.

Dubin and Navarro (1982,1983) conducted a more rigorous study to examine the relationships between regulatory climate and capital costs. Using 1978 regulatory rankings and return data, a multivariate regression model was designed using dummy variables to represent the three regulatory climates specified. Each utility was grouped into a category according to the ranking of the regulatory commission which regulates their operations. Because preliminary results indicated that there was no statistically significant difference between the average and unfavorable rankings, these two groups were combined in all subsequent tests. The grouping technique allowed the regulatory relationship to impact both the slope and the intercept of the structural relationship. Although the coefficient of determination of the resulting relationships was high, only two variables were statistically significant for the favorable grouping and only one for the average/unfavorable climate. This indicates that the relationship specified may not reflect the process that underlies the determination of the M/B relationship. Moreover, the same criticism can be leveled against this study that was applied to Trout's with respect to the use of the M/B ratio.

In an additional test, the authors considered whether gas sales contributed more to risk than electric sales. No significant effect was found. They concluded, contrary to popular belief, that gas sales did not affect the risk of utility operations any more than electric sales.

In the most recent study, Dietrich and Heckerman (1983) provide the only empirical research on regulatory risk to date that is explicitly based upon the development of an analytical model. In addition, they directly test the risk, rather than return implications of regulatory policy measures. To examine the determinants of the systematic risk of electric utilities Dietrich and Heckerman first specify a theory of regulation based upon a generalized mean variance model. Using a cash flow specification, two sources of risk are assumed. The first risk source is variation in quantity demanded, or that associated with revenue variability. The regulatory process is associated with risk through specifying a risk source based upon variability in costs not passed through when input costs are rising. The effect of regulation is specified in the average variable cost equation by assuming that in periods of rising prices regulators don't respond instantly or completely to changes in cost. This results in prices reflecting past, not current, variable costs, which in turn may result in reduced expected cash flows.

Each utility's beta is specified as a function of unit sales, total variable costs not passed through to equity holders, and capital gains to equity.

Although the authors used regulatory lag as a proxy for the regulatory process, they included two additional regulatory variables they hypothesize as having importance. Dietrich and Heckerman speculated that AFUDC earnings may be more risky than earnings from operations and so included the percentage of AFUDC earnings as a potential determinant of risk. An interim rate relief dummy variable was also included to take into account commissions that allowed increases in rates during the rate review process. The regression relationship was designed to reflect the results for an average utility. Thus, regulatory rank was not used specifically as a measure of risk, and all utilities were treated as homogeneous with respect to the type of regulation they received, with the exceptions noted above.

In general, Dietrich and Heckerman's results confirmed their expectations. Both the regulatory lag variable and the AFUDC variable were statistically significant, although interim rate relief was not. However, in evaluating the relative importance of different sources of systematic risk for the electric utilities, Dietrich and Heckerman concluded that regulatory treatment, as defined by their proxy variables, is not an important determinant of the risk measure. Instead, they conclude that growth, revenue, and cost related risk dominate the determination of beta.

While the Dietrich and Heckerman study is an important step towards analytically examining the regulatory process and its impact on risk, some questions remain as to whether the authors have adequately specified the regulatory process. Given that regulatory authorities have a significant degree of control over a number of policy variables, not just AFUDC and regulatory lag, it is probable that the net effect of regulatory treatment was not accurately reflected in the Dietrich and Heckerman study. Moreover, Dietrich and Heckerman assume homogeneity of other regulatory treatments across commissions. It is conceivable that regulatory policy when examined on average, may have little apparent impact on risk until specific regulatory groupings are considered. Significant relationships between groups may be masked when considering an aggregation of data across all utilities. The Dietrich and Heckerman study does not allow for the examination of this possibility. Finally, it is noted by the authors that electric utility betas increased across the time periods they examined. If this is so, one must question the use of a methodology that assumes stationarity of the dependent variable for the period examined. If structural instability exists, their coefficient estimates will be biased. A test for structural stability would have been easy to apply before using the time series cross sectional approach to estimate the regression model.

Summary

Despite the extensive attention given the regulated form by academicians, we find that little empirical research has been conducted to examine the relationship between regulatory regime and risk. Several studies have explicitly addressed the issue of regulation and cost of capital. The results of these studies are inconclusive due to methodological issues as well as contradictory results. In most cases, regulation was treated as a homogeneous influence across all electric utilities. This is also true of the one study that addressed the influence of regulation on systematic risk. In this case, regulation was only one of several factors which were specified as having an influence on systematic risk. Moreover, no distinction was made regarding the different levels of regulatory influence.

The current research seeks to provide empirical evidence that addresses the issue of regulatory regime and risk. In the following chapters both theoretical and empirical arguments are developed to this aim.

Endnotes

1. See Takayama [1969], Brown and Johnson [1969] and Leland [1972] for examples.

2. Klevorick [1973], Littlechild [1972], Leland [1972], Meyer [1977] are some of the authors that address the issue in this manner.

3. This approach is taken by Perrakis [1976], Littlechild [1972], Smith [1970] and Myers [1973a].

4. For example, see Copeland [1978], Howe and Rasmussen [1982], and Litzenberger and Rao [1971].

5. This relationship is mentioned by Fredrickson and Eckel [1983], Navarro [1983], Archer [1979], Davidson and Chandy [1983], Dietrich and Heckerman [1983], Trout [1979], and Weidenbaum [1974].

6. See Dubin and Navarros [1983] or Navarro [1983].

7. For example, see Meyers [1973a], Marshall, Yawitz and Greenberg [1981], Wendell [1976], Davis and Sparrow [1972], Kendrik [1975], and Malkiel [1970].

8. See Navarro [1982], Weideman [1976] and Trout [1979].

Chapter 5

REGULATORY POLICY AND SYSTEMATIC RISK

Introduction

A major concern of this research is the effect of regulatory policy decisions on the risk and market value of the regulated firm. This chapter is specifically concerned with examining the variance of equity cash flows under several regulatory conditions. From this base, a relationship between regulatory policy and systematic risk can be derived.

Earnings variability has been positively related to systematic risk in empirical studies conducted by Rosenberg and McKibbon (1973) and Beaver, Kettler and Scholes (1970). Empirical work by Lev and Kunitsky (1974) has indicated there exists a significant positive relationship between variance of cash flows and total and systematic risk. By examining the consequences of regulatory policy on a utility's cash flow, we can determine its effect on total and systematic risk.

The purpose of this chapter is purely to illustrate a possible relationship between regulatory policy and systemic risk. It is not being developed for use within the methodology section. However, it is important to consider how one might formally investigate the nature of the regulatory process and its impact on the variability of equity cash flows. It is inadequate simply to assert that the linkage exists.

Assumptions and Regulatory Conditions

General Assumptions Some simplifying assumptions are made for ease of calculation. First, the firm under consideration is engaged primarily in the production of a homogeneous product. Second, the firm is a price taker in the relevant input and output markets. It does not have the market power to affect the price paid for inputs nor the ability to affect the output price set by the regulatory authorities. In response to exogenous changes in input prices, the firm will adjust the price it charges for its output, as allowed by the regulators. Once the capital stock is chosen at the beginning of the period, the firm cannot alter it, given the time frame under consideration. Only labor and other variable cost inputs are flexible ex post. Since electricity is nonstorable, inventories are not included in this model and it is assumed that all output is sold at the price set at the beginning of the period. Reserve capacity, if held, will be treated as part of the firm's capital stock. Finally, we will assume that potential demand is sufficient to provide revenues adequate to cover potential costs and that demand for the output is known. These latter assumptions imply that the amount of productive inputs needed are known at the beginning of the period.

The purpose of this model is to examine the effects of regulation on equity cash flow variability. In this regard, only short run implications of the model are presented. Although cash flow variability will be affected by both the timing of the regulatory response and the degree to which cash flows are adjusted by the regulatory mechanism, simplicity implies a short run model. The introduction of timing effects on cash flow variability are likely to complicate the model without adding significant insight. For the purpose at hand, the short run model is sufficient to illustrate the potential impacts of regulatory policy.

Sources of Risk Two aspects of risk are considered. The first is input price uncertainty, which will affect the value of variable costs. It is assumed that input prices can be forecast without bias, although the firm will be subject to cash flow variability in periods of changing prices. The regulatory response to changing prices is the second aspect of risk. Since the firm cannot change prices without a formal rate hearing, the regulatory response when prices change will affect the ability of the firm to earn its allowed return. This regulatory response can affect cash flow variability by both the timing of its response and the magnitude of its response. In this model, only the magnitude of the response and its effect on cash flow variability will be considered. That is, the cash flow specification allows for regulators to make up, in part or whole, cost overruns or to require the recovery of cost underruns through the policy instruments employed by the regulators. The timing of cash flow deficiencies or excesses is not addressed. While this issue of policy techniques which affect timing is not treated, it is conjectured that the nature of the effect would be similar to that described below. That is, those techniques that improve the timing of cash flow recovery would be expected to reduce cash flow variability.

With this specification of regulatory uncertainty, it is expected that policy instruments relating to the magnitude of the ultimate pass-through will heavily influence the regulatory response and the market's ex ante perceptions of the distribution of stock returns. A firm allowed to employ techniques that improve cash flow recovery and stability will be perceived as less risky, relative to firms without such measures. The specification of uncertainty is general enough to incorporate these different types of regulatory responses and perceived effects.

<u>Regulatory Conditions</u> The cash flow of a regulated monopolist is developed under three separate conditions. The base model concerns that of a regulated monopolist operating under continuous regulation. This model is compared with that of a regulated monopolist facing changing input prices and discrete regulation. The latter model is

then modified to incorporate the use of regulatory policy instruments that mitigate the effects of regulatory lag and changing input prices.

Cash Flow Specification

The firm is subject to two constraints; (1) it must meed all demand, subject to capacity constraints for which it receives sales revenues of SR_{jt}, and (2) expected earnings are limited to the amount allowed by the regulatory authorities. Since demand is known, stochastic input prices are the source of variable cost, $\tilde{V}_{jt}$, uncertainty.

An all-equity, regulated utility's before tax net earnings to shareholders, $\tilde{X}_{jt}$, may be defined as:

$$\tilde{X}_{jt} = (SR_{jt} - \tilde{V}_{jt} - FC_{jt}) \tag{5.1}$$

where

SR_{jt} = total sales revenues during t;
$\tilde{V}_{jt}$ = total variable costs during t; and
FC_{jt} = total fixed costs during t.

In this case, $\tilde{X}_{jt}$ represents the net returns to shareholders as well as net earnings from operations. Regulation of the equity cash flow requires that the equity holder earn no more than the allowed return, s, on the rate base, K. K represents the original asset base net of accumulated depreciation. Given the limitation on equity ear

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earnings, it can be assumed that output price is chosen so that the expected value of the equity cash flows is equal to the allowed return, $E(\tilde{X}_{jt}) = sK$.

The before-tax earnings of the firm, $\tilde{X}_{jt}$, are related to the return on the firm's common stock, $\tilde{R}_{jt}$, by the following:

$$\tilde{R}_{jt} = \tilde{d}_{jt} + \tilde{c}g_{jt} = \frac{\tilde{X}_{jt} + \Delta\tilde{g}_{jt}}{S_{j,t-1}} \tag{5.2}$$

where

$\tilde{d}_{jt}$ = dividends per share during t;

$\tilde{c}g_{jt}$ = capital gains per share during t;

$\Delta\tilde{g}_{jt}$ = change in capitalized growth during t; and

$S_{j,t-1}$ = total market value of common stock at the beginning of t.

The capitalized growth must be added to net earnings since it represents part of the gain accruing to stockholders. This growth term reflects the expected future earnings from new assets in excess of the cost of capital. These earnings will change from period to period as new assets are added and opportunities for future earnings change. In the case of regulated utilities, the capitalized growth term will equal zero since expected earnings above the cost of capital are not allowed. As a result, we can formulate the return on equity as:

(5.3) $$\tilde{R}_{jt} = \frac{\tilde{X}_{jt}}{S_{j,t-1}} = \frac{(SR_{jt} - \tilde{V}_{jt} - FC_{jt})}{S_{j,t-1}}$$

In this model, we have specified stochastic input prices and the regulatory response as the sources of risk. Input price uncertainty implies that forecast prices will not exactly correspond to actual prices when costs are changing. Consequently, total variable costs, $\tilde{V}_{jt}$, (which are composed of the summation of stochastic input costs, $\tilde{p}_i$, multiplied by known input quantities, q_i), are uncertain. To see how this affects the total variability of net cash flow, consider the following:

Let $\hat{p}_i$ = the forecast price of the i^{th} input and,

$\tilde{p}_i$ = the actual price of the i^{th} input.

Since total revenues are required to equal total costs, this means the equity cash flow can be determined by equation (5.4):

(5.4) $$\tilde{X}_{jt} = SR_{jt} - FC_{jt} - \sum_{i=1}^{n} q_i\tilde{p}_i$$

$$= sK + \Sigma q_i(\hat{p}_i - \tilde{p}_i)$$

That is, absent any regulatory reaction, the net cash flow accruing to shareholders is a function of the ex ante allowed return and the weighted sum of forecast residuals.

To incorporate regulation, we treat the investor as knowing the form of regulation, (g), but being uncertain of the actual gross cash flow, $\tilde{X}_{jt}$, and the exact reaction of the regulators, $\tilde{\alpha}$. The following form of the regulatory reaction is assumed:

$$(5.5) \qquad \tilde{X}'_{jt} = sk + \Sigma[q_i(\hat{p}_i - \tilde{p}_i) * g_i(\tilde{X},\tilde{\alpha}_i)]$$

The net equity cash flow, adjusted for regulation, $\tilde{X}'_{jt}$, is a function of both stochastic input prices and the regulatory response. The second term, $\Sigma[q_i(\hat{p}_i-\tilde{p}_i)* g_i(\tilde{X},\tilde{\alpha}_i)]$, represents the proportional amount of the forecast error that is recovered (paid back) through regulatory policies. For example, if prices are forecast to be lower than the actual realized prices, the forecast error will be negative, resulting in cost overruns. All or part of the cost overrun may be recovered through regulatory action, $g(\tilde{X},\tilde{\alpha})$. Similarly, cost overestimation may be paid back in part or whole through the regulatory mechanism. This specification of the regulatory response allows for asymmetric policy application to cost overruns and underruns. That is, a different proportion of cost overruns may be passed through, relative to the proportion of cost underruns that have to be repaid. Similarly, this specification of the regulatory response allows for different proportions of distinct input costs to be recovered. The following restriction is placed upon the form of regulation, (g):

$$(5.6) \qquad 0 < g(\tilde{X}, \tilde{\alpha}) < 1 \qquad \text{(with probability 1)}$$

Restricting (g) to be nonnegative causes $(\tilde{X}'-sK)$ and $(\tilde{X}-sK)$ to have the same sign. This bounding prevents cash underflows, from becoming cash overflows and conversely. The restriction that (g) < 1 implies that there is no magnification of errors due to regulatory response. For example, with this specification, regulatory policy instruments introduced to mitigate the impact of rising fuel prices cannot have the effect of aggravating the cash flow problem.

Equations (5.5) and (5.6) imply that the excess gross cash flow of the utility is subject to some form of proportional scaling as a result of the regulatory response. This formulation of net cash flow effects allows damping that is not strictly proportional, e.g. excess costs might be subject to a 100 percent pass-through up to some limit and 50 percent pass-through above that limit. Also, the random parameter $\tilde{\alpha}$ can be multidimensional, indicating several distinct rules, or policies, in place that reflect the total regulatory response, and thus, the regulatory climate.

Given these specifications, we can examine the variance of equity cash flows for the utility operating under different regulatory conditions.

Cash Flow Variance

The effect of regulation of cash flow variability is presented in Figure 5.1. It is clear that the greater the regulatory response, the smaller the actual cash flow variability. This concept is discussed below.

Continuous Regulation When regulation is instantaneous and allows for full pass-through of all input cost deviations, the utility will earn its allowed rate of return with certainty. The actual cash flow variance the firm experiences is zero since all cost changes are passed through in price immediately and fully. This corresponds to a policy parameter of $\tilde{\alpha}$ such that $g(\tilde{X},\tilde{\alpha}) = 0$ for all $\tilde{X}$. The variance of the equity cash flow is:

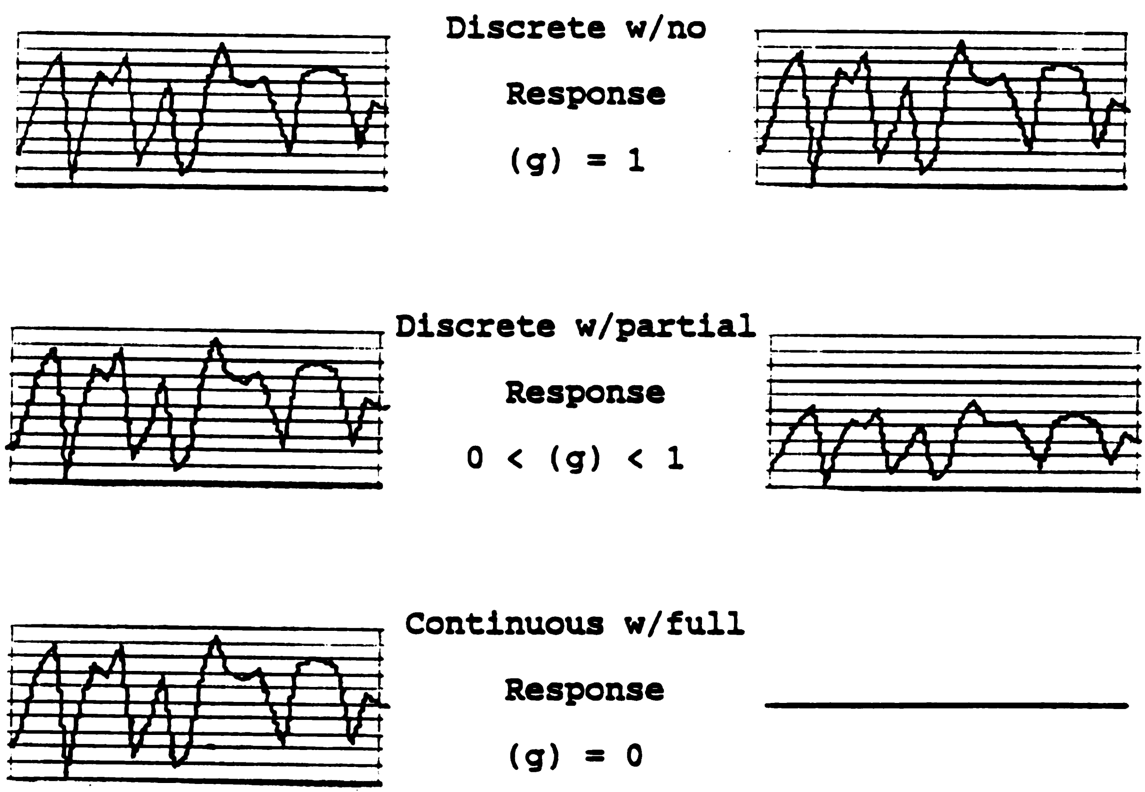
$$(5.7) \qquad \mathrm{Var}(\tilde{X}') = 0$$

Discrete Regulation With No Regulatory Response When the rate review process occurs at discrete intervals, the firm must bear the costs, or rewards, of all input cost deviations until a new rate case is heard and new prices set.

FIGURE 5.1 Equity Cash Flow Variability and Regulatory Response

Cash Flow
Variability:

Before Regulatory Response: After Regulatory Response:



If no regulatory response is initiated to mitigate the impact of changing prices between rate reviews, the firm bears all input price fluctuations. The variance of equity cash flow under these circumstances is:

$$(5.8) \qquad Var(\tilde{X}') = Var(\tilde{X})$$

$$= Var[\Sigma\, q_i(\hat{p}_i - \tilde{p}_i)]$$

Here, $\tilde{\alpha}$ is a constant such that $g(X,\tilde{\alpha}) = 1$ for all $\tilde{X}$. The regulatory response occurs but is delayed relative to the case of continuous regulations. The risk of the firm's cash flow is greater than it would be under continuous regulation because there is potential for greater than expected operating costs not being reflected in rates.

Discrete Regulation With Partial Regulatory Response

Now assume that regulatory policy instruments are implemented such that they increase the probability of earning the allowed return and reflect the regulatory climate of the commission. The cash flow distribution can be affected by keeping the expected level of return the same, but allowing the firm to respond more quickly to changing prices, in either direction. In essence, some of the risk of operations is shifted to the customer. Automatic adjustment clauses are an example of a regulatory policy that has been suggested to increase the probability of earning the allowed return in a period of changing prices.

suggested to increase the probability of earning the allowed return in a period of changing prices.

Given our assumption of unbiased price forecasts, for any (g) satisfying equation (5.5), with prob$\{g(\tilde{X},\tilde{\alpha}) < 1\} > 0$, and for any distribution of $\tilde{\alpha}$ and $\tilde{X}$, we can write the variance of equity cash flows as:

$$(5.9) \qquad Var(\tilde{X}') < Var(\tilde{X}) = Var[\ \Sigma\ q_i(\hat{p}_i - \tilde{p}_i)]$$

Under these conditions, the ability of the firm to pass through price changes shifts some of the input risk from shareholders to consumers. Table 5.1 summarizes these results.

Table 5.1 Comparison of Cash Flow Variability Under Different Regulatory Conditions

Regulatory Condition	Variance of Cash Flows
Continuous Regulation (full response)	$Var(\tilde{X}') = 0$
Discrete Regulation (partial response)	$0 < Var(\tilde{X}') < Var(\tilde{X})$
Discrete Regulation (no response)	$Var(\tilde{X}') = Var(\tilde{X})$

Under a continuous regulatory condition, all of the cash flow risk is assumed by the ratepayers, equity cash flows are insulated from input price uncertainty and the variance of the expected cash flow is zero. In the discrete model, firms with regulatory policies that allow the full impact of changing input prices to fall on the shareholders have a higher variance of equity cash flows than those without adjustment policies. The intermediate case, discrete regulation with a partial response, results in a sharing of the cash flow risk between consumers and equity holders. The proportion of relative sharing is determined by the regulatory policy of the commission.

The results of this model seem reasonable on an intuitive level. Rising input prices have a depressing effect on economic activity and, as a result, on profitability. Empirical evidence suggests that changes in input prices are negatively correlated with market returns. Consequently, the ability to insulate equity cash flows from the impact of input price variability, should decrease the systematic risk of the firm. In a homogeneous industry, where the expected level of sales is the same for all firms, differences in regulatory climate can be reflected as an adjustment to the expected level of cash flow and will subsequently affect cash flow risk. This is because the assumption is made that differences in regulatory climate affect the ability of the firm to respond to changes in input prices. The less responsive the firm is, the higher the regulation related cost of this inflexibility.

If price forecasts are biased, these results will hold as long as regulators pass-through a fixed proportion of the cash flow error. If not, the combination of biased forecasts and nonproportional pass through will result in a variance estimate that differs from equation (5.9) for the partial response condition. The nature of the difference in variance is not apparent.

Cash Flow Variance and Systematic Risk

Since equity earnings are related to stock returns, it can be expected that, all else equal, the greater the variability of earnings, the greater the risk of the stock return. This can be seen by reference to the capital asset pricing model, which defines systematic risk, B_j , as:

$$B_j = \frac{\text{cov}(\tilde{R}_{jt},\tilde{R}_{mt})}{\sigma^2(\tilde{R}_{mt})} \qquad (5.10)$$

where

$$\tilde{R}_{jt} = \text{the return on stock j in t;}$$

$$\tilde{R}_{mt} = \text{the return on the market portfolio in t;}$$

$$\sigma^2(\tilde{R}_{mt}) = \text{the variance on the market portfolio in period t; and,}$$

$$\text{cov}(\tilde{R}_{jt}, \tilde{R}_{mt}) = \text{corr}(\tilde{R}_j, \tilde{R}_m)\ \sigma_{R_j}\ \sigma_{R_m}$$

It seems reasonable to assume that in an efficient market, $\sigma^2(\tilde{R}m)$ is exogenous. The regulatory effect, if any, will be evidenced by its impact on the correlation and/or the standard deviation of the firm's cash flow. Although Rubenstein (1973) found that for most firms the corr$(\tilde{R}j,\tilde{R}m)$ is exogenous and positive, it can be argued that regulatory policy instruments affect the correlation through its impact on cash flows. Consequently, the regulatory effect is likely to affect both the standard deviation of stock returns and the correlation with the market returns. Regulatory policy instruments that reduce the variance of the firm's cash flows or the correlation of those cash flows with the market, and thus lower the covariance, will result in a reduction of systematic risk.

To see this effect more directly, consider the substitution of equation (5.3) into (5.10):

(5.11)
$$B_j = \frac{\mathrm{cov}[\frac{SR_{jt} - \tilde{V}_{jt} - FC_{jt})}{S_{j,t-1}}, \tilde{R}_{mt}]}{\sigma^2(\tilde{R}mt)}$$

If we assume that the regulatory response is applied only to changes in input costs other than capital, we can specify this relationship as;

(5.12)
$$B_j = \frac{\mathrm{cov}[\frac{sK + \Sigma[q_i(\hat{p}_i - \tilde{p}_i) * g_i(\tilde{X}, \tilde{\alpha}_i)]}{S_{j,t-1}}, \tilde{R}_{mt}]}{\sigma^2(\tilde{R}mt)}$$

(5.13)
$$\frac{\mathrm{cov}[\frac{sK}{S_{j,t-1}}, \tilde{R}_{mt}]}{\sigma^2(\tilde{R}_{mt})} + \frac{\mathrm{cov}[\frac{\Sigma[q_i(\hat{p}_i - \tilde{p}_i) * g_i(\tilde{X}, \tilde{\alpha}_i)]}{S_{j,t-1}}, \tilde{R}_{mt}]}{\sigma^2(\tilde{R}_{mt})}$$

With the observation that the first covariance term in equation (5.13) reduces the zero.

Given the assumptions of this chapter, we would expect that the same utility firm under different regulatory conditions would be subject to a different level of risk as a result of the regulatory response, and hence, the regulatory climate to which the utility is subject. The firm within an environment with full pass-through of input cost changes will have a lower covariance than if it faced no pass-through. As a result, the systematic risk of the full pass-through condition will be lower.

The preceding example suggests that systematic risk will be affected by the regulatory treatment the utility firm receives. While the illustration is purely conjectural, it does point out the nature of the problem at hand.

Chapter 6

RESEARCH DESIGN

The first four sections of this chapter consist of a description of the sample selection, data sources, time period and portfolio grouping method. The fifth section describes the procedures used for risk estimation. A similar presentation for the performance measures is found in the sixth section. An overview of the research focus is presented in the seventh section as a prelude to Chapter 7. The final section is a summary of the chapter.

The association between regulatory regime and risk can be evaluated by comparing risk measures of utility portfolios which have different regulatory climate rankings. Capital market data will be analyzed to determine if significant differences in risk exist between these portfolios of electric utilities. In essence, we are asking if regulatory climate rankings contain significant information content. Second, the return measures of the portfolios will be examined to ascertain to what extent returns to each portfolio compensated for risk over the period in question.

Sample Selection

The firms investigated in this study are large electric utilities whose return and regulatory data was available from public sources. A sample of 85 publicly traded electric utilities was selected for analysis. To be included in the sample each firm had to meet certain specifications. Monthly stock price return data for the 1974-1984 period had to be available for each company from the CRISP tapes. Similarly, firm data on fuel use had to be available from the Department of Energy for the same period. Only those utilities with more than 60 percent of revenues from electric operations were included. This cutoff was made to avoid the issue of whether electric utilities with substantial gas sales had different risk characteristics than those without [1]. In cases where a utility serviced more than one state, a firm was included only if 75 percent of operations were under one state jurisdiction or the rankings of adjacent state commissions were equivalent.

Holding companies were not included in the sample, nor were firms with operations in Texas, Minnesota, and South Dakota included for all years. Only in those months for which state regulation existed were firms in these states included [2]. Nebraska utilities were not included since all utilities in that state are publicly owned.

Time Period

The period of this study is from January 1974 to December 1984. Such considerable change occurred in the electric utility industry over this time period that estimates of statistical relationships might be biased if the entire period were used. To address this issue, structural stability tests were employed to examine the potential for changes in risk and return measures over the entire period. If not accounted for, such instability would potentially bias estimates of the empirical model. The purpose of such tests is to divide the sample period into subperiods of relatively stable structural relationships. This subgrouping allows more efficient parameter estimates and the ability to test for significant changes in the estimates.

No single event can be identified as that which may have led to the market's reevaluation of the utility industry or a shift in risk profile. Instead, any change in the industry is better characterized as the result of a cumulative series of events and information that, when aggregated over time, reached a critical mass at some undesignated epoch. As a result, any statistical technique used to test for structural shifts must allow for an unknown shift point.

Three methods were used to test for unknown point of structural change. These methods are: a squared residuals test; a maximum likelihood test; and a Chow test. Each procedure is described below.

A squared residuals test is conducted by selecting several points of likely change and running pairs of regressions, one for each likely combination of time periods. That pair which has the smallest total sum of squared residuals indicates the point of change. This procedure can accommodate more than two structural relationships and continuous switching of the regime. Error variances are assumed to be equal.

If error variances cannot be assumed equal, the likelihood ratio test can be applied to identify when the parameters of an economic relationship changed. What this method allows us to do is to determine whether a structural shift has occurred and whether the shift was statistically significant. In general, the test consists of forming a likelihood ratio for each possible combination of time and selecting the point of change as that where the likelihood ratio is maximized.

The Quandt switching regression [3] can be used for this application. This model assumes that two separate regimes generate the observations; the first m observations define Regime 1 and the subsequent t-m observations define Regime 2. In application, this method estimates two regressions for a given portfolio and total time frame, for all possible divisions in the time interval. For each regime, the market model is estimated and a likelihood function formed. The likelihood ratio can be defined as:

$$\lambda = \frac{\hat{\sigma}_1^t \hat{\sigma}_2^{T-t}}{\hat{\sigma}^T}$$

where $\hat{\sigma}_1^{t}$ and $\hat{\sigma}_2^{T-t}$ are the standard error of the estimate of the first time block and adjacent time block regressions, respectively. The standard error of estimate of the overall regression, using all observations, is represented by σ^T. In large samples, this ratio has a Chi-square distribution of degrees of freedom r, where r represents the number of parameters specified by the null hypothesis.

The Chow Test [4] also allows a test of parameter stability and does not require the assumption of equal error variances to be valid. A Chow test is essentially an F test in which there are (K+1) and ($T_1 + T_2$ -2K) degrees of freedom. It is formed as:

$$F = \frac{[SSE_c - SSE_{uc}\}/(K+1)}{SSE_{uc}/(T_1 + T_2 - 2K)}$$

where T_1 is the number of observations in the first period, T_2 is the number of observations in the second period, and K is the number of regressors, including the intercept, in the unconstrained regression. SSE_c represents the sum of squared residuals resulting from running one regression on all the data for the total time period of interest. This contrains all the regression parameters to be the same in both periods. The SSE_{uc} is formed by adding the SSE of each subperiod regression under consideration. With two separate regressions for each time period the parameters are allowed to differ in each regime.

Data Sources

Monthly stock return data were obtained from the Center for Research on Securities Prices (CRSP) tapes available from the University of Chicago. These tapes include electric utility firms which are traded on the New York Stock Exchange and the American Stock Exchange.

Market parameters were obtained from the CRSP tapes. The CRSP equally weighted market index with dividends was used as a surrogate for monthly market return data. The 90-day Treasury bill rate served as the proxy for the return on the riskless asset. These rates were obtained from Federal Reserve Board data.

Operating data, such as electric and gas sales revenues, were extracted from the information available in Moody's Public Utility Manual. The Statistics of Privately Owned Electric Utilities in the United States, published by the Department of Energy, was the source of the fuel expense data. Information on regulatory methods and rate cases, when needed, was obtained from the Edison Electric Institute's Electric Rate Case Decision Data, Public Utility Reports, and the National Association of Regulatory Utility Commissioners, Annual Report.

Finally, an average of five regulatory ranking services was used to assign a utility firm a regulatory regime for the years 1978 to 1984. This procedure parallels that used in empirical studies which employ regulatory rankings. Prior to 1978, an average of three ranking services was used because of data unavailability. The average rank assigned by these three services had a correlation of .93 relative to the average rank assigned by all five services in the 1978-1984 period. Although some bias is introduced by moving from a three rank to a five rank average, it is thought this bias is small due to the high correlation. The five firms providing the regulatory rankings were Merrill Lynch, Soloman Brothers, Duff and Phelps, Argus, and ValueLine. The latter three were those services providing rankings for the 1974-1977 period. Studies by Archer (1979a,b,c) and Navarro (1983) also indicate that the equality of the rankings assigned commissions by investment advisory services is very high. As a result, we would expect that the risk measures associated with each portfolio would not be significantly different.

Each service ranks commissions according to different ordinal scales (usually between 4 and 10 categories, depending upon the service). Following the method employed in previous research, rankings for each service were classified into two categories--favorable and average. The purpose of such a combination was to facilitate comparisons between risk measures derived from different ranking agencies and to allow for reasonable portfolio size. In addition, it facilitates comparisons of the results of this research with other studies of regulatory climate rankings.

The rankings for all services were provided on a quarterly or biannual basis. Conversion to a monthly basis was made by assigning the same rank to every month which the ranking period covered.

Portfolio Groupings

The individual securities of each firm were assigned into equally weighted portfolio groups according to the regulatory climate ranking associated with the respective state commission. For example, Michigan's regulatory climate was ranked as "unfavorable" in 1979. This means that Detroit Edison and Consumers Power were placed in the unfavorable portfolio for that time period. Firms were shifted to new portfolios when a new rating was announced by the rating agency. The composition of the portfolio changed from month to month as the regulatory rank of the associated commissions changed. Firms were switched to new portfolios in the month in which it was announced by the investment advisory service that the regulatory climate ranking of the associated commission had been revised. Although the composition of the portfolios will be different over time, all the firms in a portfolio are assumed to have the same characteristics. Moreover, an examination of the rankings of the commissions indicates that there is a high degree of stability in the rankings over time. For example, in the Duff and Phelps data, twenty-three commissions did not have a rating change over the 1972-1984 period. Twelve commissions experienced a single rating change, ten commissions experienced two rating changes and three commissions had their rating changed three times. Although this stability indicates that the variance of the portfolio should not be significantly affected by these changes, the possibility of heteroscedasticity existed. Subsequent tests for this influence indicated it was not present.

Portfolio level analysis, rather than firm level analysis, was employed for two reasons. First, more precise statistical estimates are obtainable with a portfolio grouping since estimation error is reduced relative to single firm analysis. Second, this grouping controls for any changes in the level of industry risk over the time period not associated with differences in regulatory climate ranking. Measures of individual firm risk differences will include differences due to both industry and regulatory rank influences if the level industry risk has been changing. It would not be possible to distinguish the source of the risk effect if both firm and industry risk were changing differentially. By using relative measures of risk, through this grouping technique, any change affecting the industry as a whole will not affect the relative level of risk, assuming all firms are affected similarly.

Risk Measure Estimation

Several measures of risk are estimated for each utility portfolio. The measures are systematic risk, total variance, coefficient of variation and an ex post risk premium. Each measure will be described briefly in this section. Sharpe, Lintner, and Mossin [5] have developed an equilibrium model that linearly relates the expected return on any asset to marketwide parameters and the relative market risk of that asset. Relative market risk is measured by the covariance of a security's returns with the market relationship. This relationship is expressed as:

$$(6.1) \quad E(R_i) = R_f + [E(R_m) - R_f]B_i$$

where

$E(R_i)$ = the expected rate return on asset i

R_f = the rate of return on the riskless asset

$E(R_m)$ = the expected rate of return on the market portfolio

B_i = cov(Ri,Rm)/Var(Rm). B_i is a measure of the proportional contribution of asset i to the risk of the market portfolio

Several assumptions underlie the single period two parameter model. These include assumptions with respect to perfect capital markets, rational investors, homogeneity of expectations among investors, equal access of all traders to the market, absence of market imperfections, costless and available information, maximization of end of period wealth, equal borrowing and lending rates, and restrictions against short selling. A more detailed discussion of the assumptions associated with the model can be found in Rubenstein (1973) or Elton and Gruber (1981).

Although these assumptions do not necessarily reflect reality, they allow for the development of a useful framework for describing the required return on a risky asset. Moreover, as long as the model provides an adequate description of risk and return relationships, it is a useful tool.

Various extensions to the capital asset pricing model, as the two parameter model is often called, have been made in an attempt to reduce some of the restrictive assumptions underlying it. The major alternative to the Sharpe, Lintner, Mossin (SLM) model is one developed by Black (1972). By assuming that equal borrowing and lending rates do not exist, he develops a model identical to the SLM model except that the risk free rate is replaced by a minimum variance, zero beta portfolio. Beta remains the appropriate measure of relative market risk and a linear relationship between expected returns and risk is maintained. Merton (1973) extends the CAPM into a continuous time model, assuming continuous trading and a log normal distribution of security returns. Again, the resulting model is identical to the SLM, if the risk free rate is nonstochastic, except for the use of instantaneous rates of return and the log normal distributions. With a stochastic risk free rate, the model is based upon investors holding three funds; the market portfolio, the riskless asset, and a portfolio whose returns are negatively correlated with the risk free asset. Other assumptions have been relaxed by researchers but the model remains fairly robust to these changes [6].

Empirical tests of the CAPM have been extensive. Among the major studies published are those by Black, Jensen and Scholes (1972), Fama and McBeth (1973) and Litzenberg and Ramaswamy (1979) [7]. The inadequacy of the two parameter model is suggested by consistent findings of an intercept term significantly greater than the risk free rate. Most studies use the 90-day Treasury bill as an approximation to the risk free rate. In addition, empirical studies indicate that other variables are successful in explaining the portion of security returns not explained by beta [8]. While the simple two parameter model has not been completely validated with these tests, the studies largely agree that systematic risk is the dominant measure of risk and that there exists a positive linear tradeoff between risk and expected return.

Roll (1977) criticizes the use of the empirical two parameter model for measuring security performance and for testing the model in general. He argues that because the true market portfolio cannot be observed, the model is not testable. The implication is that tests of the two parameter model that are performed are tests of what has occurred, not of expectations. These tests simply represent a joint test of the model and of the data which underlie the tests. Despite Roll's strong criticism, Mayers and Rice (1979) conclude that tests of performance, information effects, and the model itself are valid, though not problem free.

Because the two parameter model is an ex ante expectational model, empirical tests require the use of the ex post form of the model. The ex post form is expressed in the following manner:

(6.2) $R_{it} - R_{ft} = (R_{mt} - R_{ft})B_i + e_i$

where

R_{it} = the return on the security in period t

R_{ft} = the return on the riskless asset in period t

R_{mt} = the return on the market portfolio in period t

B_i = the systematic risk of security i

e_i = the residual term, E(ei) = 0.

Measures of the risk parameters associated with a security or portfolio can be determined with the ex post model. This approach is discussed more fully in the following section.

Risk Measures

An implication of the two parameter model is that investors will only pay to avoid market related risk. This arises from the result that investors can diversify away all risk except that variability systematically related to general market moves. The total risk of a security or a portfolio has two components, market related risk and firm specific risk. This risk is the total variance of the firm and is formally expressed as:

(6.3) $\sigma_i^2 = B_i^2\sigma_m^2 + \sigma_{ei}^2$

where

σ_i^2 = The variance of security i.

σ_m^2 = The variance of the market.

σ_{ei}^2 = The residual variance of security i.

When a single security is held, the investor faces the entire return variability associated with that security. Consequently, the risk of holding the security in isolation is the total variance. As additional securities are added to the investor's holdings, return comovements mitigate firm specific risk. In well-diversified portfolios firm specific risk (σ_{ei}^2) is eliminated through diversification. As a consequence, total risk is equal to the remaining market risk ($B_i^2\sigma_m^2$) and total variance is at a minimum.

Estimates of both components of risk are examined in this research. Although many researchers have shown that the only relevant risk is systematic risk, others take issue with this conclusion. As Lev (1978) notes, when markets are imperfect and investors diversify inefficiently, systematic risk does not reflect the risk of a security. Under these circumstances, the choice of a risk measure is a function of the investor's holdings and subsequent information needs. For well-diversified investors, beta can be used as a measure of risk since firm specific risk is diversified away. For investors with poorly diversified holdings, a measure of total risk becomes more appropriate. This is because an asset's return variability will not be reduced to a minimum by the comovement of other asset returns. As a result, the total risk of poorly diversified holdings contain both firm specific and market related risk.

The portfolios formed in this study are poorly diversified since they consist of firms from a single industry. This implies that the total variance of the portfolio is not minimized. Conceivably, regulatory climate rankings can affect both market and firm specific risk. Because of this, and the comments above, it is important to examine the extent to which risk differences are related to market and firm specific components of risk.

Two other measures of risk will be examined. The first, coefficient of variation (CV), provides a relative measure of total risk when average returns are unequal. This measure is determined as follows:

$$\text{(6.4)} \qquad CV = \sigma_i/\bar{R}_i$$

CV is the coefficient of variation, SDi represents the standard deviation of asset i, and Ri is the asset's return for a given time period. The higher the CV, the greater the risk per unit of return.

A final measure of risk is the premium earned over and above the riskless rate of return. Ibbotson and Sinquefeld (1978) found that over the 1926-1977 period, equity risk premiums averaged 8.8 percent and corporate bond risk premiums averaged 1.7 percent [9]. Although general in approach, the risk premium measures offer an intuitively appealing and simple concept of risk.

Performance Measures

While the risk measures discussed in the previous section lend insight into relative risk components, the comparisons ignore the return performance of the portfolios. If differences in the risk parameters are significant, we would expect to find significant differences in expected return. Adjusted for risk, we would expect relative return performance to be equivalent across all portfolios. Although all that can be measured is ex post return performance, the assumption of market efficiency implies that expected returns should not be systematically different from realized returns. Moreover, the examination of relative return performance can provide an indication of whether average security returns to a portfolio were adequate to compensate for the associated level of ex post risk. Measures of risk adjusted performance can be made by using one of the measures below:

Sharpe's reward to variability ratio $$S = \frac{\bar{R}j - \bar{R}f}{SDj}$$

Treynor index $$T = \frac{\bar{R}j - \bar{R}f}{Bj}$$

Jensen's measure of abnormal performance $$\alpha = (Rj - Rf) - Bj(Rm - Rf)$$

where

$\bar{R}j$ = the mean return on the jth portfolio

$\bar{R}f$ = the mean return on the risk free asset

SDj = the standard deviation of return on the jth portfolio

Bj = the estimated systematic risk of the jth portfolio

α = Jensen's measure of abnormal return performance

For a well-diversified portfolio, each relative measure will given consistent results with respect to the performance rank. The greatest divergence between measures occurs when portfolios are not well-diversified and may result in inconsistent performance rankings. The divergence is not a problem as long as we recognize the differential information each measure provides us with.

The choice of a relative performance measure rests with the investor and is related to the relative diversification of the investor. For the well diversified investor, Treynor's or Jensen's measure is appropriate. Investors with poorly diversified holdings face both systematic and firm specific risk. Consequently, Sharpe's measure, employing standard deviation, is a better benchmark of relative portfolio performance.

Purpose of the Empirical Research

At this point, prior to the discussion of the empirical tests, an overview of the purpose of this research may be useful. In this regard, consider the three related questions this research addresses:

I. A. Are there differences in risk measures between portfolios of regulated firms differentiated only by regulatory climate ranking?

B. Does the fuel mix of a utility have a significant impact on the risk measures associated with a regulatory climate portfolio? That is, are there differences in the estimates of risk measures for regulatory climate portfolios when further classified according to major fuel source?

II. Were there differences in the risk adjusted performance measures between portfolios for the time periods of interest?

III. Have the average risk and performance measures associated with each portfolio remained stationary across the entire period of study?

The first set of questions addresses the issue of cross-sectional variations in volatility of return associated with differences in regulatory climate. Because the electric utility industry is substantially a homogeneous sector, it is assumed that there are no significant influences on risk other than the regulatory climate of the jurisdiction the utility operates in. The cash flow model of Chapter 5 suggests that the regulatory process can affect the risk of the firm. If this is so, we would expect to see an inverse relationship between the risk of the portfolio and regulatory climate.

Realistically, we would also expect those firms operating with a fuel mix largely composed of gas and oil to be more subject to the rising fuel price impacts of the 1970's, and thus, potentially, subject to greater regulation related risk. To address this concern, the regulatory climate portfolios were partitioned into portfolios according to the major source of fuel. For each regulatory climate rank p (favorable and average) there were (a) a total portfolio of rank p, (b) a subportfolio of rank p with gas and oil as the primary source of fuel, and (c) a subportfolio of rank p with all other fuel source characteristics. Following Clark (1980), utilities for which gas and oil constitute over 65 percent of the fuel source were placed in subportfolio (b). This grouping allowed a test of whether utilities with different fuel mix characteristics have a significantly different risk profile.

The relative performance of each portfolio grouping is examined in the second question. The purpose of this analysis is to determine if significant differences in return performance were evident for portfolios of a particular regulatory climate rank. In an efficient market we would expect risk adjusted return performance across all assets to be equal and not significantly different from realized returns. However, unexpected changes in risk, resulting from regulatory actions, may have created the potential for windfall gains and/or losses over the study period. For this reason, ex post return performance was reviewed.

As a result of the tumultuous decade the electric utility industry has experienced, it is of interest to examine the risk and performance relationships of regulatory groupings over time. These are the concern of the third question. As discussed earlier, it seems reasonable to suspect that the risk profile of the industry changed as both the economic environment and regulatory responsiveness underwent substantial change. Questions of both the direction of change in risk and the stability of risk parameters are brought into question as a result. In examining the components of risk in the electric utility industry over the decade of the 1970's, Melicher (1978) concluded that "increasing utility risks were perceived as being no greater than increasing risks associated with other common stocks." On a relative basis, however, he found that unsystematic risk had increased for the industry since the mid-1970's. Since regulatory climate rankings reflect not only systematic risk influences but unsystematic considerations as well, the question of changing risk components and the composition of total risk are of interest. This provides an incentive to consider the impact on diversified, as well as nondiversified investors [10].

Summary

In conclusion, this research empirically estimated risk and return relationships over the 1974-84 time period to determine if statistically significant differences could be detected in portfolios of homogeneous firms except with respect to regulatory climate ranking. Assumptions with respect to market efficiency, information impounded in return distributions, and the ability of the CAPM to provide an adequate representation of risk and return, were made to facilitate the research. The empirical evidence provided will contribute to the discussion associated with the implied impacts of differences in regulatory policy and will potentially provide useful information for investors predicting ex ante risk levels.

ENDNOTES

1. Joskow (1972) argues that gas utilities are more risky than electric utilities. An implication of this argument is that combined gas and electric utilities are more risky than pure electric utilities. The empirical research has not been conclusive on this matter of relative riskiness. However, Dubin (1983) found no significant differences in return and risk associated with the amount of gas revenues in a combination electric utility. Utilities with 10, 20 and 30 percent of their revenues derived from gas (as opposed to electricity) were tested. Although the relative percentages tested covered a fairly narrow range, it does not seem unreasonable to use a benchmark of 40 percent of gas revenues or less benchmark for the current research.

2. Minnesota and South Dakota were under Home Rule until 1975; commission regulation in Texas began in 1976.

3. A survey of regime switching techniques can be found in Goldfeld and Quandt (1976) chapter 1. See also Quandt (1958).

4. Maddala (1977) presents an excellent discussion on changing parameter models (pp 390-404). See also Chow (1960).

5. See Sharpe (1964), Mossin (1966), or Lintner (1965).

6. For a more complete discussion of the results see Elton and Gruber Modern Portfolio Theory and Investment Analysis, Chp. 12, Wiley and Sons, New York, 1981.

7. For a review of many of the tests associated with the two parameter model see Copeland and Weston (1983) or Elton and Gruber (1981).

8. For example, Fouse (1976) adds a liquidity measure to CAPM, Bar-Yosef and Kolodny (1976) who examine the addition of dividends, or Banz (1981) who considers the effect of firm size.

9. Ibbotson, R. and Sinquefeld, R. Stocks, Bonds, Bills and Inflation: The Past: (1926-1977) and the Future (1977-2000), Financial Analysts Research Foundation, Charlottesville, Virginia. 1977

10. This point was discussed previously. See also Elton and Gruber (1980) 483-497.

CHAPTER 7

STATISTICAL RESULTS

Introduction

This chapter presents data on the risk and return characteristics of electric utility stock portfolios. The research covers the period January 1974 to December 1984. The results of the analysis suggest that significant differences in risk and performance profiles existed for electric utility portfolios formed on the basis of regulatory regime. Consequently, this research provides support for the information content of regulatory ranking services. Evidence also suggests that the primary fuel mix employed by a utility had a contributory influence on risk and performance. The implication of these results is that the electric utility industry could not be considered a homogeneous risk class industry during the entire period of time studied.

In the first part of this chapter the results of the structural stability tests are examined. Estimates of the risk and return measures of the regulatory regime portfolios are presented next. Fuel mix portfolios for each regulatory portfolio are subsequently formed and estimates of risk and return measures discussed. The chapter concludes with a summary of the results.

Structural Stability Tests

It was argued in an earlier chapter that the structural stability of the utility industry over the 1974-1984 time frame was questionable. In addition, many studies (1) have concluded that beta is unstable over time. We would thus expect structural instability to be present in the electric utility industry over the period of study. If present and not accounted for, such instability would bias estimates of the empirical model. As discussed in the previous chapter, this issue could be explicitly addressed by arranging the analysis into time periods of known structural stability. However, this approach is not possible here since it is not known when structural change(s), if any, occurred. Instead, it is possible to determine potential points of structural change. In this study, three methods were used to test for an unknown shift point(s). These methods are a squared residuals test, a maximum likelihood test and a Chow test. A description of these tests is contained in

TABLE 7.1 Estimation of Structural Change: Electric Utility Portfolios 1974-1984

Technique	Indicated Point of Change	Test
Minimizations of Squared Residuals	1974-1977 / 1978-1984	n/a
Chow Test	1974-1977 / 1978-1984	F = 6.77*
Likelihood Test	1974-1977 / 1978-1984	X = 20.88*

* significant at the 5% level. df = (3,128) for the Chow Test and (4) for the Likelihood Test.

Chapter 6. Summary results for each test are reported in Table 7.1. All three test results indicate that a structural difference in the market model estimates for the utility portfolios occurred between the periods 1974-1977 and 1978-1984. During each of these periods, estimates of alpha and beta could be considered relatively stable, on average. However, the average level of parameters is indicated to be different for each period of time. These results imply that a shift in portfolio excess returns, a change in systematic risk or both, occurred. As a result of the structural shift tests, subsequent analysis of the portfolios was based upon three time periods, 1974-1977, 1978-1980 and 1981-1984. Although no indication of structural change was evident for the latter break point, it was made arbitrarily to allow for more optimum sized portfolios. In general, portfolios with between 36 and 60 observations provide the most efficient coefficient estimates.

The first period represents a time of substantial upheaval and uncertainty in the electric utility industry. If differences in regulatory responses exist, they are likely to be strongest during this first period. The second period corresponds to a time of greater industry and regulatory experience in responding to a dynamic environment. Fuel price increases and substantial uncertainty were still evident in the industry. Consumer groups were increasingly active during this period and aggressively opposed regulatory mechanisms that would increase electricity prices in the short run. Construction programs were extensive and, in many cases, burdened the utility with severe cash flow requirements. However, by this time, both regulators and utility managers were seasoned by the previous years. Regulatory regime differences may have been mitigated by the experience of the industry. The most recent time period, 1981-1984, represents a period of greater financial health for the utility industry. Construction programs initiated in the 1970's were completed, nearing completion or cancelled. Consequently, the cash flow drain on the utility firms was easing. Fuel price increases had moderated or, in the case of oil prices, had decreased. The 1981 Tax Recovery Act initiated changes in the tax laws that benefited the utilities through improved cash flow. As a result, while differences in regulatory regime may still exist, the relative influence of regulatory response to risk may be less important.

REGULATORY PORTFOLIO RESULTS

Testing for Differences in Systematic Risk

The beta coefficient for each portfolio was estimated with the ex post form of the capital asset pricing model. Using ordinary least squared regression, the firm's monthly

TABLE 7.2 Estimated Average Systematic Risk ($\bar{B}_p$): Regulatory Regime Portfolios

	Regulatory Regime		
	Favorable	Average	
Period	$\bar{B}_p$	$\bar{B}_p$	T-Test of Difference
1974-1977	.5765	.6876	7.56*
1978-1980	.3217	.3942	3.24*
1981-1984	.3426	.3814	1.98*

* denotes significance at the 5% level. df = 94,70 and 94 for each period, respectively.

excess rate of return on equity was regressed against the market excess rate of return. Table 7.2 provides these estimates for each time period.

In all periods, the systematic risk measure for the average portfolio is significantly greater than that of the favorable portfolio. These results suggest that utilities in an average regulatory regime had greater systematic risk in the periods studied. This implies that the regulatory commission rankings were successful in distinguishing between aggregate risk levels in the electric utility industry during these periods.

The level of systematic risk, for any portfolio, becomes less pronounced over time. A Chow test of coefficient equality was applied to determine if the change in a portfolio's systematic risk over time was significant. Table 7.3 provides the results of this procedure.

TABLE 7.3 Stability Test of Systematic Risk: Chow Test

Period	Portfolio Favorable	Portfolio Average
Beta: 1974-1977	.5765	.6876
1978-1980	.3217	.3942
F Statistic	7.24*	8.95*
Beta: 1978-1980	.3217	.3942
1981-1984	.3426	.3814
F Statistic	2.67	2.89

* denotes significance at the 5% level; df = (3,78).

Not surprisingly, these results parallel those of the structural stability tests described earlier. A significant decrease in systematic risk for portfolios of both regulatory regimes is evident between the the first two periods considered. By the second comparison, portfolio betas have increased for the average portfolio, but not significantly. Nor is the increase in the systematic risk of the favorable portfolio significant.

These results suggest that there was a significant difference in the systematic risk of portfolios distinguished by regulatory regime. This difference was evident in all periods. Moreover, a significant downward shift occurred in the risk level of the industry after 1977.

Differences in Variance

In recognition that systematic risk may not be the only relevant measure of risk to the investor, an estimate of total risk is also provided. For each portfolio the variance of returns was estimated and is presented in Table 7.4.

TABLE 7.4 Estimated Variance: Regulatory Portfolios

Period	Favorable	Average	F Statistic	S&P 500
1974-1977	.00282	.00343	1.22	.00488
1978-1980	.00162	.00168	1.04	.00371
1981-1984	.00099	.00142	1.43	.00212

df = (47,47), (35,35) and (47,47) for each period, respectively.

In all periods, the level of the average portfolio variance is greater than that of the favorable portfolio. However, the difference is not significant, as measured by an F test. Bartlett's test for homogeneity of variance produced similar results. Regulatory regime does not appear to be associated with differences in variance of return. In all cases, the level of variance for the utility portfolios is lower than market variance. The level of variance fell over the decade for all portfolios, including the market portfolio. As indicated by Table 7.5, the decline was significant only in the first comparison period for the average portfolio.

TABLE 7.5 Stability of Variance:
Regulatory Portfolios

Period	Favorable	Average	S&P 500
1974-1977	.00282	.00343	.00482
1978-1980	.00162	.00168	.00371
F statistic	1.74	2.04*	1.32
1978-1980	.00162	.00168	.00371
1981-1984	.00099	.00142	.00212
F statistic	1.64	1.18	1.75*

*significant at the 5 percent level. df = (47,35) and (35,47) for each comparison, respectively.

Other Measures of Risk

Two other measures of risk were estimated and are reported in Table 7.6. The coefficient of variation (CV) was estimated by dividing the standard deviation of portfolio returns by the average portfolio return. The risk premia were determined by subtracting the 90-day Treasury bill rate from the monthly portfolio return. In two cases out of three, the average portfolio had a coefficient of variation that exceeded the CV of the favorable portfolio by more than 15 percent. The exception occurs in the middle period where the coefficient of variation for the average portfolio is about 11 percent less than the favorable portfolio CV.

Risk premia measures indicate that the excess returns to the favorable portfolio were greater than the average portfolio in two of three cases. It is interesting to note that the portfolio with the smaller beta had a higher risk premia. We would expect just the opposite, ex ante. In this case, investors choosing the favorable portfolio would have acquired the lower risk investment and the highest average returns.

TABLE 7.6 Coefficient of Variation & Risk Premia Estimates: Regulatory Regime Portfolios

	Coefficient of Variation ($\bar{R}_p/\sigma_p$):		Risk Measure Difference: Avg. - Fav.	
Period	Favorable Portfolio	Average Portfolio	Difference	Percent Difference
1974-1977	4.28	5.05	.77	18.0
1978-1980	11.53	10.40	-1.13	10.9
1981-1984	1.68	2.64	.96	57.1

	Risk Premia ($\bar{R}_p-\bar{R}_f$):		Excess Return to Average Portfolio (Average - Favorable)	
Period	Favorable Portfolio	Average Portfolio	Difference	Percent Difference
1974-1977	.00756	.00674	-.00082	12.2
1978-1980	-.00418	-.00372	.00046	12.4
1981-1984	.01015	.00577	-.00438	75.9

The cumulative results of examining these risk measures suggest that the average portfolio is, in general, more risky than the favorable portfolio. These results hold for all measures of risk employed, except the risk premia method. The null hypothesis that the risk of the two portfolios is equal is not, in general, supported.

Performance Measures

Next, we turn to the issue of performance. In equilibrium we would expect the risk adjusted returns of these portfolios to be identical. Because the stock market is seldom in equilibrium, it is reasonable to ask to what extent excess returns may have accrued to these utility portfolios over the decade studied. In this section, three performance measures are compared and considered, the Sharpe, Treynor and Jensen measures.

As was discussed in an earlier chapter, the proper risk measure depends upon the assumed amount of investor diversification. For non-diversifiers, total variance is appropriate. At the same time, diversified investors concern themselves with systematic risk. The performance measures considered here differ in applicability due to the risk measures implicit in the calculations.

Sharpe's performance measure was determined by dividing the actual average monthly excess return by the portfolio's standard deviation of return. Table 7.7 summarizes these estimates for each portfolio. In two of three periods, the favorable portfolio exhibited higher ex-post risk adjusted returns than the average portfolio, despite the higher risk of the latter. During the middle period, the reward to variability ratio was negative for both portfolios, indicating negative excess returns ex-post. In this case, the Sharpe measure for the favorable portfolio is more negative than that of the average portfolio. This indicates the risk adjusted return to the favorable portfolio was less than the return to both the average portfolio and the Treasury bill during the period. Nonetheless, investors holding only utilities in favorable regimes would have experienced a greater risk/return tradeoff than those holding only average regime utilities when considering the entire decade.

TABLE 7.7 Sharpe's Performance Measure: Regulatory Regime Portfolios

$$S_{pm} = (\bar{R}_p - \bar{R}_f)/\sigma_p$$

Period	Favorable Portfolio	Average Portfolio	Excess Return to Average Portfolio (Average-Favorable) Units	% Difference
1974-1977	.1416	.1144	-.0272	23.8
1978-1980	-.1041	-.0908	.0133	14.6
1981-1984	.3220	.1525	-.1695	111.1

Sharpe's performance measure assumes investors hold only one risky security. For these investors, standard deviation constitutes the appropriate risk measure. Investors who hold the market portfolio will want to consider either the Treynor index or Jensen's alpha for evaluating performance.

Treynor's performance measure is similar to the Sharpe measure except that the average monthly excess return premium is divided by the portfolio's systematic risk. As with the Sharpe measure, in equilibrium, the index across all portfolios is expected to be identical. Any positive deviation greater than the market index is considered evidence of superior portfolio performance. Negative deviations are indicative of poor relative performance. Table 7.8 presents the results of estimating the Treynor index for the utility portfolios. These results correspond to those associated with the Sharpe performance index. That is, despite higher relative risk measures, the average portfolio has a smaller ex post performance level than the favorable portfolio, on average, over the decade.

TABLE 7.8 Treynor's Performance Measure: Regulatory Regime Portfolios Tpm = $(\bar{R}_p - \bar{R}_f)/\hat{B}_p$

Period	Favorable Portfolio	Average Portfolio	Excess Premium: Average Portfolio (Average-Favorable) Units	% Difference
1974-1977	.0131	.0098	-.0033	33.7
1978-1980	-.0130	-.0094	.0036	38.3
1981-1984	.0296	.0151	-.0145	96.0

One of the problems associated with both the Treynor and the Sharpe performance measures is the inability to test for the significance of the findings. Jensen's performance measure of alpha resulting from the Jensen regression can be tested using a simple t-test. Jensen's performance measure is similar to Treynor's in that both assume investors are well-diversified. The level of alpha indicates to what extent a portfolio outperformed (alpha > 0) or underperformed (alpha < 0) the market for a given period. As indicated in Table 7.9, relative direction of the results for Jensen's measure is similar to that of Treynor's measure. That is, the favorable portfolio outperforms the average portfolio, on average. However, in all but one period the excess returns to each portfolio were not significantly different from zero. Consequently, when performance is measured relative to systematic risk, and tested for significance, it appears there was little material difference between the performance characteristics of the two regulatory portfolios. Only in the last period,

Table 7.9 Jensen's Performance Measure: Regulatory Regime Portfolios

Period	Favorable Portfolio	Average Portfolio
1974-1977	.0012	-.0008
	(.234)	(.168)
1978-1980	-.0086	-.0092
	(-1.428)	(-1.606)
1981-1984	.0083	.0037
	(2.092*)	(.764)

T statistics are shown in parentheses

* denotes significance at the 5% level. df = 47, 35 and 47 for each period, respectively.

1981-1984, did the favorable portfolio earn significantly positive returns. As a consequence, this portfolio outperformed both the market and average regulatory rank portfolios. However, on average, investors earned zero excess returns for holding these portfolios, as we would expect.

In summary, it is evident from these results that the favorable utility portfolio outperformed the average portfolio in most cases when risk is measured by standard deviation and Treynor's index. If risk is measured relative to the market with Jensen's index, and tested for significance, there was little difference between the performance of the two portfolios.

FUEL BASED REGULATORY PORTFOLIO RESULTS

Generating Capacity: Risk and Performance

Other factors besides regulation affected the value of the utility stocks during the last decade. In particular, the prices of fuel for generation significantly increased.

TABLE 7.10 Fossil Fuel Price Changes
1974 - 1983
(average annual % change)

Period	Coal	Oil	Natural Gas	Consumer Price Index
1974-1977	11.96%	7.67%	38.35%	7.35%
1978-1980	7.93	54.86	31.61	12.38
1981-1983	6.51	-9.42	14.40	4.66

Source: Statistical Abstract of the United States 1985, U.S. Department of Commerce.

Table 7.10 indicates the relative price changes for the major fuel sources.

In general, all fuel prices showed substantial increases when compared to the consumer price index. Within this group, oil and gas prices rose at a much faster rate than coal prices.

To separate out potential value changes attributable to differential changes in fuel prices, the regulatory portfolios were partitioned into fuel based subportfolios. Consequently, the average portfolio was divided into two portfolios. One portfolio consisted of firms where oil and gas represent over 65 percent of the fuel used for generation. A second portfolio was composed of firms where coal represents over 65 percent of the fuel used. The same procedure was applied to the favorable portfolio.

This classification is representative of generating capacity combinations. Typically, a company will use coal or oil generating plant to provide baseload electricity. Natural gas is used to supplement baseload output during peak demand periods. Exceptions occur in areas, such as Texas, where natural gas supply is in close proximity to the utility plant. In these cases, it is not unusual to find natural gas plant providing close to 100 percent of generating capacity. The characteristics of each fuel portfolio are summarized in Table 7.11.

Testing for Differences in Systematic Risk

The null hypothesis is that for any regulatory regime the systematic risk of the oil and gas portfolio is equal

TABLE 7.11 Characteristics of the Fuel Based Regulatory Portfolios

Characteristic	Favorable Regime		Average Regime	
	Oil & Gas	Coal	Oil & Gas	Coal
Average # Firms	11	17	25	32
Average Generating Capacity:				
Oil & Gas	93%	24%	90%	26%
Coal	7	76	10	74

Note: Nuclear capacity is not included in these totals. On average, nuclear capacity represents about 10% of total U.S. generating capacity.

to that of the coal portfolio. This implies that the systematic risk of a utility would not be affected by the type of fuel employed.

For the utilities in the favorable regime, a significant difference in systematic risk is evident between the fuel portfolios in the first two periods. As indicated in Table 7.12, the oil and gas portfolio exhibited a higher degree of systematic risk than the coal portfolio. By the third period, no significant differences are discernible. These results are reasonable in light of the significant changes in oil and gas prices, relative to coal, over the first two periods. Despite favorable regulation, with fuel costs representing between 25 and 30 percent of operating revenues, it is not surprising that increased variability in a major input would be reflected in an increase in perceived risk.

TABLE 7.12 Estimated Average Systematic Risk ($\hat{B}_p$): Comparison of Fuel Portfolios Within a Regulatory Regime

	Favorable Portfolio:			Average Portfolio:		
Period	Oil & Gas	Coal	TTest	Oil & Gas	Coal	TTest
1974-1977	.6167	.5426	4.70*	.6929	.7440	3.69*
1978-1980	.3745	.2870	3.84*	.3957	.4007	.23
1981-1984	.3492	.3387	.59	.3422	.3857	2.34*

* denotes significance at the 5% level
df = 94, 70 and 94 for each period, respectively.

The results for the average regime portfolios indicate that fuel source influences were of an opposite nature. In the first and third period, the coal portfolio exhibited substantially more systematic risk than the oil and gas portfolio. While the direction of the risk impact is just opposite that of the favorable portfolio, it is difficult to draw conclusions about the underlying cause. Several factors may have contributed to this result. During this time period, coal based companies with large construction programs were looked upon unfavorably. At the same time, environmental control requirements were placed upon coal generating plant that required substantial investments. Consequently, systematic risk levels for coal capacity may be higher for these companies, especially if it is perceived that regulators will not be fully responsive to these difficulties. These factors may be the cause for the higher level of systematic risk for the average regime coal portfolio.

Another factor which may be influencing the results is related to nuclear capacity. Nuclear capacity was not accounted for because data was not availabile. However, the large construction programs in nuclear plant and the increasing uncertainty regarding completion of such programs had great influence on the financial health and perceived risk of the firms involved. These influences may be combining in such a way to mask the relationship regarding risk influence.

Although the influence of fuel source is pervasive, it does not appear to be a major factor in the differences between regulatory regimes. An examination of Table 7.13 supports this suggestion. In all cases, the average regime subportfolio had a greater level of systematic risk than the corresponding favorable regime subportfolio. In over half of the comparisons the difference was significant. This is true for all of the coal portfolio comparisons. In all periods, the coal portfolio of the average regulatory regime exhibited significantly greater systematic risk than the comparable portfolio of the favorable regulatory regime.

Similar results hold for the oil and gas comparison. In all periods, the average regulatory portfolio had greater systematic risk than the comparable favorable portfolio. However, only during 1974-1977 was the difference significant.

TABLE 7.13 Estimated Average Systematic Risk ($\hat{B}_p$): Comparison of Fuel Portfolios By Regulatory Regime

	Primary Fuel: Oil & Gas			Primary Fuel: Coal		
Period	Favorable Portfolio	Average Portfolio	T Test	Favorable Portfolio	Average Portfolio	T Test
1974-1977	.6167	.6929	4.96*	.5426	.7440	14.14*
1978-1980	.3745	.3957	1.04	.2870	.4007	4.73*
1981-1984	.3492	.3422	0.31	.3387	.3857	2.49*

* denotes significance at the 5% level
df = 94, 70 and 94 for each period, respectively.

The results of this section indicate that there was a pervasive difference between the fuel portfolios of a given regulatory regime. However, the exact nature of this influence was not consistent. Notwithstanding, the relationship between the average and favorable portfolios was maintained. In every instance, the average regime portfolio exhibited a higher level of systematic risk than the favorable portfolio. These differences were consistent across time and across fuel source distinctions.

Other Risk Measures

Regarding differences in other risk measures, the null hypothesis is that for any regulatory portfolio the risk measure of the coal portfolio will equal that of the oil and gas portfolio. Table 7.14 summarizes the comparison of variance and the coefficient of variation (CV) for each portfolio. The evidence displayed in Table 7.14 shows that there is no significant difference in variance between the coal and the oil and gas portfolios. The null hypothesis of no difference cannot be rejected.

TABLE 7.14 Variance & Coefficient of Variation Estimates: Comparison of Fuel Portfolios Within a Regulatory Regime

	Favorable Portfolio			Average Portfolio		
Risk Measure	Oil & Gas	Coal	F	Oil & Gas	Coal	F
Variance:						
1974-1977	.0034	.0026	1.31	.0023	.0038	.61
1978-1980	.0014	.0019	.74	.0016	.0017	.94
1981-1984	.0010	.0010	1.00	.0020	.0012	1.67
Coefficient of Variation:			Percent** Difference			Percent** Difference
1974-1977	4.64	4.13	12.3	2.78	4.83	42.4
1978-1980	6.82	24.27	71.9	8.91	11.76	24.2
1981-1984	1.61	1.77	9.0	2.37	2.46	3.6

* denotes significance at the 5% level

** The basis for percent calculation is the coal portfolio, i.e., percent difference = (oil and gas - coal)/coal. df = (47,47), (35,35) and (47,47) for each period, respectively.

The coefficient of variation (CV) results are mixed. With the exception of the 1978-1980 period, the CV is about the same for each of the favorable portfolios. During the middle period, the CV of the coal portfolio is over three times as large as that for the oil and gas portfolio. Similar results were found for the unfavorable portfolio. However, in this regime the coal portfolio CV was only about one and a half times as large as the oil and gas portfolio CV. Construction program cancellations and stiff environmental regulations concerning coal may account for the observed effects.

Turning to the average risk premia, Table 7.15 shows that the oil and gas utility portfolio experienced greater average excess returns than did the coal portfolio, over each time period. In the middle period, where excess returns were negative, the oil and gas portfolios exhibited

TABLE 7.15 Risk Premia Estimates: Comparison of Fuel Portfolios Within a Regulatory Regime

Period	Favorable Regulatory Regime			Average Regulatory Regime		
	Oil & Gas	Coal	Percent* Difference	Oil & Gas	Coal	Percent* Difference
1974-1977	.0077	.0074	4.0	.0126	.0078	61.5
1978-1980	-.0022	-.0059	62.7	-.0031	-.0041	24.4
1981-1984	.0110	.0098	12.2	.0103	.0058	77.6

* The basis for the percent calculation is the coal portfolio.

smaller losses than the coal portfolios. This was especially true for the favorable utilities where the coal portfolio had negative returns over 60 percent greater than the oil and gas portfolio.

In summary, these results suggest that a firm's primary fuel mix has a contributory influence on risk measures. Measures of systematic risk indicate that favorable utilities employing oil and gas for generation had higher risk, on average, than those utilizing coal for generation. Average regime utilities showed opposite results, on average, with coal based utilities exhibiting more risk. While risk premia measures indicated that oil and gas portfolios experienced higher premiums than coal portfolios, it remains to be seen whether this relationship holds when returns are risk adjusted. In general, no other significant, consistent differences in risk measures were indicated for the fuel generating portfolios when considering the measures of variance and coefficient of variation. The issue of risk adjusted returns will be addressed in the following section.

Performance Measures: Fuel Based Portfolios

Table 7.16 presents Sharpe's risk return performance measure for each utility portfolio. On an aggregate level, the oil and gas portfolio experienced better risk adjusted performance than the coal portfolio. Investors who used

TABLE 7.16 Sharpe's Performance Index: Comparison of Fuel Portfolios Within a Regulatory Regime

$(S_{pI} = (\bar{R}_p - \bar{R}_F)/\sigma_p)$

Favorable Regulatory Regime:	1974-1977	1978-1980	1981-1984
Oil & Gas Portfolio	.13188	-.05899	.35032
Coal Portfolio	.14637	-.13606	.30307
Excess Return to Oil & Gas:	-.01449	.07707	.04725
% Difference	11.0	130.6	13.5
Average Regulatory Regime			
Oil & Gas Portfolio	.25986	-.07697	.23092
Coal Portfolio	.12716	-.09928	.16407
Excess Return to Oil & Gas:	.13270	.02231	.06685
% Difference	104.4	29.0	28.9

standard deviation as a measure of risk would have had greater return performance if they had invested in these utilities. The exception occurs in 1974-1977 for the favorable regulatory regime portfolio where the oil and gas portfolio has risk adjusted returns 11.0 percent lower than the coal portfolio.

Table 7.17 provides the Treynor performance index for each of the fuel based portfolios. For investors concerned with systematic risk, investment in the oil and gas based portfolios would have led to greater risk adjusted returns, on average. These results correspond to those using standard deviation as a measure of risk. The excess return to the oil and gas portfolio, relative to coal ranged

TABLE 7.17 Treynor's Performance Index: Comparison of Fuel Portfolios Within a Regulatory Regime

$$T_{PI} = (\bar{R}_P - \bar{R}_F)/\hat{B}_P$$

Favorable Regulatory Regime:	1974-1977	1978-1980	1981-1984
Oil & Gas Portfolio	.01249	-.00587	.03150
Coal Portfolio	.01364	-.02021	.02893
Excess Return to Oil & Gas:	-.00115	.01434	.00257
% Difference	9.2	244.3	8.2
Average Regulatory Regime:			
Oil & Gas Portfolio	.01811	-.00789	.03007
Coal Portfolio	.01053	-.01031	.01493
Excess Return to Oil & Gas:	.00758	.00242	.01514
% Difference	41.9	30.7	50.3

between 8 percent and 244 percent. Only in one instance, 1974-1977 for the favorable range, was the excess return to oil and gas negative. In this case, the coal portfolio earned a risk adjusted return that was about 9 percent greater than the oil and gas portfolio.

The results of measuring Jensen's alpha for each of the fuel portfolios are reported in Table 7.18. In all but two case, the risk adjusted returns of each portfolio are not significantly different from zero. As a result, one cannot

TABLE 7.18 Jensen's Performance Index: Comparison of Fuel Portfolios Within a Regulatory Regime

Favorable Regulatory Regime:	1974-1977	1978-1980	1981-1984
Oil & Gas Portfolio	.00092	-.00741	.00914
	(.16)	(-1.46)	(2.34)*
Coal Portfolio	.00142	-.00988	.00798
	(.29)	(-1.45)	(1.92)
Excess Return to Oil & Gas:	-.00050	.00247	.00116
% Difference	54.3	33.3	12.7
Average Regulatory Regime:			
Oil & Gas Portfolio	.00089	-.00862	.00847
	(.19)	(-1.53)	(1.38)
Coal Portfolio	-.00034	-.00970	.00372
	(-.07)	(-1.67)	(.84)
Excess Return to Oil & Gas:	.00123	.00108	.00475
% Difference	361.8	12.5	56.1

T values are indicated in parentheses.
* denotes significance at the 5% level.
df = 47, 35 and 47 for each period, respectively.

say the fuel portfolios are significantly different from each other. The only exception occurs during the 1981-1984 period for the oil and gas portfolio of the regulatory regime. In this instance, this portfolio earns a positive return that is significantly different from zero and from the coal portfolio of the same regime.

This section has indicated that the risk adjusted return performance of the oil and gas portfolio was generally higher than that of the coal portfolio. This was true when both standard deviation and systematic risk were considered in measuring performance by using either a Sharpe or Treynor index. However, the results were different when the Jensen measure was utilized. While the oil and gas portfolios continued to exhibit higher risk adjusted returns, the results were not statistically significant.

Summary

The implications of this research are twofold. First, evidence is presented that implies the systematic risk of an electric utility is attributable, in part, to the regulatory climate within which it operates. Consequently, the electric utility industry cannot be designated an equal risk industry without first considering regulatory influence. The impact of regulatory commission policy has a pervasive and material impact on the operating and financial risk of the firms it regulates. As such, this research indicates that the information provided by regulatory ranking services has value. Moreover, there is evidence in this study that the primary fuel source a utility employs influences its systematic risk. While the exact nature of this influence is not clear, further study can be directed to address this issue.

The results of this research should surprise no one. The issues of regulatory risk and cost of capital have long been discussed in the financial press. What this research does contribute is the first effort to empirically establish the validity of the arguments raised. It points out in a direct manner that regulation is not exogenous to the utility firm's risk and return profile. Regulators concerned with minimizing total costs need to be concerned with the overall impact of their actions on the firm's cost curve. Managers interested in determining equity costs on a comparable firm basis have another factor to consider in determining comparability. This study provides support for more direct attention to the link between regulation and firm risk.

ENDNOTES: RESULTS

1. For example, Blum (1975), Brigham & Crum (1977), Fabozzi and Francis (1979) and Pettway (1978).

CHAPTER 8

SUMMARY AND CONCLUSIONS

The risk and performance characteristics of electric utility stock portfolios were examined in this research. In itself, this study differed significantly from previous studies in its approach and scope. First, the present study explicitly incorporated regulatory climate as a factor influencing risk. Regulatory climate portfolios were formed in a manner to test directly for the effect of regulation on measures of risk and performance. Although current literature has addressed the topic of regulation and risk, it has focused on the topic indirectly by relating regulatory differences to cost of equity measures, not risk. Thus, this study adds new evidence to previous research on regulatory influences.

A secondary goal of this research was to define the problem of regulatory risk and regulatory climate and examine how investors' perceptions of these concepts may impact security cash flows. Although the concept of regulatory risk has been widely discussed in the literature, it has rarely been defined nor has the relationship between regulatory risk and cost of capital been analytically developed. This research is a first step towards a more specific definition of regulatory risk.

Finally, an analytic model was developed to describe the potential link between regulatory policy, which determines regulatory climate, and measures of security risk. While several research studies have considered the relationship between cost of equity and thus risk, none have linked their tests to a theoretical framework that incorporated regulatory risk. Although the model developed in this research was purely illustrative, it represents an important component of empirical work.

Summary

The objective of this study was to investigate whether the risk and performance characteristics of electric utility portfolios differed significantly when portioned by regulatory climate rankings. Risk and performance differences were assessed by testing portfolios of electric utilities portioned by regulatory climate. It was hypothesized that if regulatory climate differences existed, those portfolios with a favorable climate would have a lower level of measured risk than the comparable average climate portfolios. Similarly, it was hypothesized that ex-post performance measures would not be substantially different across any of the portfolios.

Monthly beta coefficients were estimated for each equally weighted portfolio of securities. In addition, measures of variance, risk premia and coefficient of variation were estimated. The Sharpe, Treynor and Jensen performance measures were estimated for each portfolio as well.

The results of the beta coefficient estimates indicated that the average regime portfolio had a significantly higher level of systematic risk than the favorable regime portfolio. The other measures of risk estimated indicated mixed results. However, in general, they suggested that the average portfolio was more risky than the favorable portfolio.

Measures of ex-post performance for each portfolio indicated that while the favorable portfolio had a higher level of risk adjusted returns, neither portfolio had excess returns significantly different from zero.

To determine whether the primary source of a utilitys' generating fuel influenced the risk level, the regulatory portfolios were further partioned into fuel portfolios. Estimates of risk and performance were derived for a coal and oil and gas portfolio for each regulatory portfolio. It was hypothesized that the oil and gas portfolio for any regime would have a greater level of risk than the related coal portfolio. Performance measures were again hypothesized to not be significantly different across portfolios.

The results of the risk measure estimates indicated that a pervasive fuel influence was present but not the same for the regulatory regimes. The oil and gas portfolio of the favorable regime exhibited a higher beta coefficient than the coal portfolio, as hypothesized. However, the results were just opposite in the average regime. In this case, it was the coal portfolio which had a higher level of systematic risk, on average. No significant excess returns were indicated for any of the fuel portfolios.

Conclusions

The results of the analysis suggest that pervasive risk differences do exist between regulatory portfolios. In general, portfolios of average regulatory rank had higher levels of measured risk than did portfolios of favorable regulatory rank for the period studied. The market's perception of the riskiness of electric utility firms was found to be associated with the regulatory climate rankings provided by ranking services. It appears that the more favorable the regulatory climate a utility was exposed to, the lower the associated risk and, by association, equity costs.

This research also found that the primary fuel a utility firm used for generation exerted an influence of the risk profile of the firm. Although the influence was not consistent in direction across all regulatory groupings, it was significant and consistent in existence.

Two factors may be responsible for the inconsistency in results associated with fuel mix. As mentioned in an earlier chapter, nuclear capacity was left out because of data difficulties. However, this omission may be biasing the results to the extent that nuclear construction programs and operating difficulties became much more pronounced during this period. In addition, a substantial participation in construction programs by a firm may have had a severe impact on cash flow and financial health during the period of study. If so, the risk measures associated with such a firm may be substantially different than those for which construction programs were minor. Further study should be directed at these issues.

Despite the difficulties with the fuel mix results, a significant influence was evident. In addition, the regulatory regime influence was maintained. That is, for either portfolio within a fuel category, the average regime portfolio always exhibited a higher level of systematic risk that the favorable portfolio. Thus, there does not appear to be a confounding influence associated with the combination of regulatory risk and fuel mix characteristics.

Implications

The present research has provided evidence that may be of use to at least three identifiable groups. The implications of these findings for each of these groups are discussed below.

Members of the investment community may have a direct interest in the results of this research. This research has reported statistically significant evidence of a relationship between regulatory climate rankings and an electric utility's measure of systematic risk. This evidence is supportive of the information content of the data incorporated in the regulatory rankings made available by investment advisory services. These results indicate that investors should be concerned with the regulatory climate of the utility firm(s) they are interested in. This is especially true in light of the evidence that suggests that while risk differences were evident among the utility portfolios, ex-post performance showed evidence of favoring the favorable regime utilities. If so, the most efficient investment would have been in the favorable portfolio where risk was lower and average return higher, relative to the average portfolio. Moreover, the research suggests that the regulatory climate data used may be of use to investors in the assessment of regulatory climate.

The results of this research are also of interest to utility managers because of their concern with cost of equity estimation. This study adds new evidence to previous assertions that regulatory climate is associated with the risk, and therefore, the cost of equity for an electric utility firm. As such, when determining the cost of equity of comparable firms, managers should consider whether the regulatory climate of the firms under consideration are similar. In such a context, the incorporation of a ranking of regulatory climate would appear to be a useful consideration in obtaining a group of comparable firms.

Regulators were identified as a third group who may have an interest in the results of this research. To the extent that differences in regulatory climate arise from differential application of identifiable regulatory policies, knowledge of this relationship can be used to improve evaluation of current or proposed policy changes. Further, if it is the goal of regulators to minimize total costs, their own contributions to capital costs, through their policy choices, should be recognized.

Limitations of Study

The most severe limitation associated with this study relates to the inability to account for the relative presence of nuclear capacity in a utility's plant. This omission may be responsible for the directional inconsistency found in the systematic risk measures of the fuel portfolios. Public sentiment fueled by the Three Mile Island accident, coupled with difficulties in operations of nuclear plant during this time period, may have significantly affected investors perceptions of the riskiness of nuclear based utilities. Moreover, those utilities with large construction programs, either coal or nuclear, faced substantial cash flow pressures during the late 1970's and early 1980's. These factors, in conjunction with public sentiment against cost overruns in the construction programs, may have also affected investors perceptions of security risk.

Suggestions for Future Research

Further research may overcome some of the limitations of this current research. In recent years, nuclear capacity data by firm has become more readily available. The difficulty is to find comparable data for the earlier periods. Sources indicate that the Energy Information Administration's recent computerization may allow for more public access of nuclear capacity information on a firm level basis. Another alternative is to survey utility firms and request the information. With this data one could also examine the potential for risk shifts of firms with and without nuclear capacity on a pre- and post-Three Mile Island accident basis.

An additional extension of this study would be to develop an event study that examined whether a change in systematic risk occurred when a rating change was announced. Given that the present research finds a difference between risk levels of different regulatory climates, we would expect to find a change in risk when a rating change from one category to another was announced.

APPENDIX

APPENDIX A

SAMPLE FIRMS

Arizona Public Service Company
Atlantic City Electric
Baltimore Gas and Electric
Boston Edison Company
Carolina Power and Light

Central Hudson Gas and Electric
Central Illinois Light
Central Illinois Public Service
Central Maine Power
Cincinnati Gas and Electric

Cleveland Electric Illuminating
Commonwealth Edison
Consolidated Edison of NY
Consumers Power
Dayton Power and Light

Delmarva Power and Light
Detroit Power
Duke Power
Duquesne Lighting Co.
El Paso Company

Empire District Electric
Florida Power and Light
Gulf State Utilities
Hawaiian Electric
Houston Industries

Idaho Power
Illinois Power Co.
Indianapolis Power Co.
Interstate Power
Iowa Electric Light and Power

Iowa Resources
Iowa-Illinois Gas and Electric
Iowa Public Service
Kansas City Power and Light
Kansas Gas and Electric

Kansas Power and Light
Kentucky Utilities
Long Island Lighting
Louisville Gas and Electric
Minnesota Power and Light

Missouri Public Service
Montana Dakota Utilities
Montana Power
Nevada Power
New York State Electric and Gas

Niagara Mohawk Power Corporation
Northern Indiana Public Service
Northern States Power
Ohio Edison
Oklahoma Gas and Electric

Otter Tail Power Company
Orange and Rockland Utilities
Pacific Gas and Electric
Pacific Power and Light
Pennsylvania Power and Light

Philadelphia Electric Corporation
Portland General Electric
Potomac Electrical Power
Public Service Co. of Colorado
Public Service Co. of Indiana

Public Service Co. of New Hampshire
Public Service Co. of New Mexico
Public Service Electric and Gas
Puget Sound Power and Light
Rochester Gas and Electric

St. Joseph Light and Power
San Diego Gas and Electric
Savannah Electric and Power
Sierra Pacific Power Company
South Carolina Electric and Gas

Southern California Edison
Southern Indiana Gas and Electric
Southwestern Public Service Company
Tampa Electric
Texas-New Mexico Power

Toledo Edison
Tucson Electric Power Company
Union Electric
United Illuminating Company
Utah Power and Light

Virginia Electric and Power
Washington Water Power
Wisconsin Electric Power
Wisconsin Power and Light
Wisconsin Public Service Corp.

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