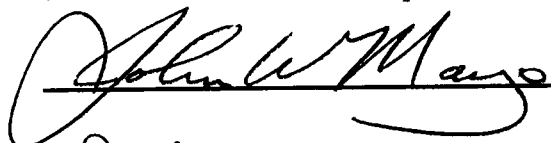


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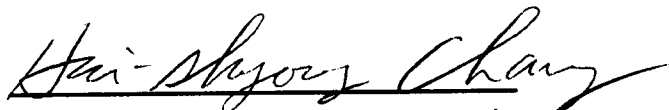
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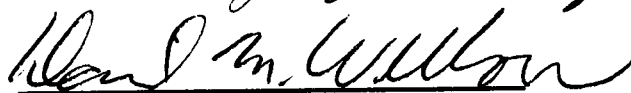
  
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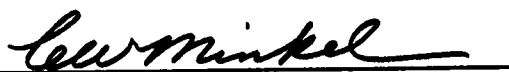








Accepted for the Council:

  
Vice Provost  
and Dean of The Graduate School

THE ENDOGENEITY OF THE ALLOWED RATE OF RETURN  
AND THE ECONOMIC THEORY OF REGULATION

A Dissertation  
Presented for the  
Doctor of Philosophy  
Degree  
The University of Tennessee, Knoxville

Bae-Geun Im

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**ABSTRACT**

Most of the Averch-Johnson type literature on the behavior of the regulated firm assumes that the allowed rate of return is exogenously given to the regulated firm. This assumption, however, ignores the real possibility that the regulated firm may influence the decision making process of the regulator and thereby change regulatory outcomes. In fact, a considerable body of literature, beginning with the seminal work of Stigler (1971), indicates that the regulated firm has some control over the regulator. Given this control, regulation becomes endogenous to the firm's decision making process.

This dissertation, both theoretically and empirically, explores the endogeneity of regulation and its implications. In particular, the various state regulatory commissions' determination of the allowed rate of return permits us to examine the possibility of the endogeneity of the allowed rate of return. A simple theoretical model shows that the regulated firm is able to increase its allowed rate of return by influencing the regulator.

A three-equation recursive system of state regulatory commissions' determination processes of the allowed rate of return is developed so that we can identify determinants of the allowed rate of return and also explore whether or not the regulatory outcome is changed by the firm's influence. The variable representing the degree of the firm's influence used in this study is regulatory expenses -- the expenditure that the firm incurs in its attempt to influence regulatory outcomes. Subsequently, the thesis develops a simple model to derive the firm's optimal level of regulatory expenses and constructs hypotheses

concerning the determinants of these optimal expenses. The data employed in these tests pertain to 122 electric utility rate cases decided between 1980 and 1984.

The empirical results indicate that the allowed rate of return is subject to the influence that the firm wields in the regulatory hearing process. This provides support for the hypothesis that the rate-of-return constraint is endogenous to the regulated firms. Moreover, the empirical results also indicate that the firm's investment in influencing regulatory outcomes is responsive to factors suggested by the theory of optimal regulatory expenditure that is derived. At a more general level, the results support the approach embodied in the economic theory of regulation.

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## CHAPTER I

### INTRODUCTION

#### 1. Purpose of the Study

Since Averch and Johnson (A-J) (1962) first analyzed the behavior of a regulated firm, several studies have not only examined the model's theoretical properties but also have attempted empirical tests of the A-J hypothesis.<sup>1</sup> The general framework of the model is that the regulated firm maximizes its profit subject to a fair rate-of-return on its capital but cannot exceed a certain allowed rate of return set by the regulatory commission.

It is noted that most of the A-J literature assumes that the allowed rate of return is exogenously determined.<sup>2</sup> The allowed rate of return is simply given rather than determined within the model. But this assumption rules out the possibility of any influence of the firm on the determination process by the regulatory commission of the allowed

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<sup>1</sup>The theoretical examinations of the A-J model include Takayama (1969), Baumol and Klevorick (1970), Corey (1971), Bailey and Coleman (1971), and Bailey (1973). The empirical studies of the A-J model are Courville (1974), Spann (1974), Petersen (1975), and Boyes (1976).

<sup>2</sup>Although Klevorick (1971) recognized the endogeneity of the allowed rate of return in examining the optimal fair rate of return, it is not in the same sense as it is endogenous here. He allows the regulatory agency to react to A-J type behavior of the firm and set the allowed rate of return so as to maximize social welfare. He does not allow the firm itself to influence the allowed rate of return. Sheshinski (1971) also does not recognize the firm's influence in determining the optimal allowed rate of return although he allows the allowed rate of return to vary within the model in response to the maximization of the social welfare function.

rate of return. This questionable assumption motivates us to explore the allowed rate of return, several aspects of the commission regulation, and the behavior of the regulated firm as reflected in the determination of the allowed rate of return.

The objectives of the present study are threefold. First, the study is intended to specify and estimate a simple model of the regulatory commission's determination of the allowed rate of return on equity. In so doing we can identify factors affecting the rate of return set by the regulatory commission. The empirical specification is designed to capture the formal regulatory proceedings of actual rate cases. The basic approach to specifying the model is similar to Joskow's (1972) in that behavioral equations for each party in a rate case are specified. At the same time, it differs from Joskow's (1972) approach in that an additional equation, a commission staff equation, is included in the model. Also, the system of equations including the commission staff equation employs different variables and data, not for one state as Joskow used but for 37 states.

Second, the study attempts to demonstrate both theoretically and empirically that the regulatory commission's decision is subject to influences from the regulated firm and that the allowed rate of return is not determined exogenously. The endogeneity of the allowed rate of return can be indirectly tested by including a variable representing influence of the firm as an independent variable in the commission equation for the determination of the allowed rate of return.

Third, a key variable for measuring the degree of influence from the firm used in the study is the regulatory expenses incurred by the

regulated firm.<sup>3</sup> The study will also focus on the firm's optimal level of regulatory expenditures and the determinants of these optimal expenses. In the framework of Stigler's economic theory of regulation (1971), the allowed rate of return may be viewed as a product supplied by regulators and regulatory expenses as the price (or cost) paid by regulated firms to obtain favorable regulation. By examining the economic determinants of the firm's regulatory expenses, we can derive and test several implications in the context of the economic theory of regulation.

## 2. Significance of the Study

This study is expected to be significant in at least three aspects. First, this study can provide an empirical evidence whether the regulated firm has some degree of control over the regulatory process. Specifically, the study can show whether the regulated utilities influence the state regulatory commission's determination of the allowed rate of return. Thus far, the existing literature has not produced any empirical studies relating to this specific aspect of the endogeneity of regulation. This study may also be regarded as a test of the robustness for the Stiglerian version (1971) of the economic theory of regulation, which asserts that government regulation is obtained by the regulated firm and operated mainly for its interest.

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<sup>3</sup>The regulatory expenses are all expenses incurred by the utility in connection with formal rate cases (e.g., conducting cost of capital studies, hiring expert witnesses, preparing accounting reports, etc.), including expenditures incurred in influencing regulatory outcomes.

Second, if the regulated firm is able to exert an influence on the regulatory commission and thereby affect regulatory outcomes, then regulation is no longer exogenous to the firm's decision making. Certainly this dimension of the endogeneity of the allowed rate of return in particular and the endogenous regulation in general should be taken into consideration in future modelling of the behavior of the regulated firm.

Third, in the absence of any fixed formula for setting the rate of return on equity by the regulatory commissions, it is meaningful to develop a simple model of the determination process of the allowed rate of return and to examine what factors affect that process. This will also allow us to understand the structural framework of the regulatory commission decision process.

### 3. Organization of the Study

The problem and objectives of the study are described in chapter I. Chapter II provides a background on state commission regulation. In particular, methods of calculating the allowed rate of return frequently mentioned in actual rate cases are reviewed. The third chapter presents a brief literature review pertaining to the determination of the allowed rate of return and the economic theory of regulation, which provides an implicit explanation for the behavioral strategy of the firm towards regulation. In chapter IV the endogeneity of the allowed rate of return and its implication on the behavior of the regulated firm is examined. Then the regulatory commission's determination of the allowed rate of return is empirically modelled. The data and empirical results are also

discussed in this chapter. In chapter V a simple model of the firm's optimal level of regulatory expenses is developed and then the determinants of these optimal regulatory expenses are hypothesized and tested. Chapter VI summarizes and concludes the study.

## CHAPTER II

### A BACKGROUND ON COMMISSION REGULATION

#### 1. Rate-of-Return Regulation

The most common mode of regulating the price and profit of the regulated firm is rate-of-return regulation. Basically the firm is allowed to set a rate (or rate schedule) which will cover its expenses and result in a fair rate of return on its invested capital.

The governing principles of the rate-of-return regulation are: (a) rates and charges of the firm to customers should be just and reasonable, (b) returns on the investment of shareholders and investors should be fair, and (c) the return to the shareholders and investors should be sufficient to attract necessary amount of investment to maintain the firm.

There are two major phases in the rate-making process. First, the regulatory commission determines a general level of rates or prices under which the firm is allowed to earn a fair rate of return on its capital base. Next, the commission has to approve the proposed structure of rates by the regulated firm.

#### 1) The Determination of the Rate Level

The general practice to find the appropriate level of rates is done with a revenue requirement standard. Rate-of-return regulation is basically a cost-plus form of price setting. The firm is allowed to earn overall revenues sufficient to cover its operating costs plus a normal profit. This can be expressed in the following simple formula:

$$RR = OC + S(V - D)$$

where RR = revenue requirement

OC = allowable operating costs

S = allowed rate of return

V = gross value of assets (capital or investment)

D = accumulated depreciation

(V - D) = net value of capital or rate base.

The determination of the revenue requirement involves several steps. First, the commission along with the firm will generally select a test period, usually the most recent twelve months for which appropriate data are available to reflect the actual operating results and experience. All parties involved in the rate case utilize the test period in presenting their evidence. The commission may make certain adjustments to test year data in order to reflect more current operating conditions.

Second, the allowable operating costs of the test period are determined and adjusted to reflect normal conditions which might be expected to occur during the period in which the proposed rates are expected to be effective. Operating costs include materials and supplies, fuel, wages and salaries, maintenance, annual depreciation charges, and taxes. Although operating costs typically represent about three-fourths of the total revenues, evaluation of the operating costs provided by the firm does not take much time. Generally, the estimate of costs provided by the firm is accepted by the commission with little modification. However, if the commission considers some expenses imprudent or excessive, it may not allow those expenses.

Third, the commission determines the rate base which consists of the property of the firm 'used and useful' for the provision of utility service within its state.<sup>4</sup> Since the product of the allowed rate of return and the rate base constitutes the profit of the firm, the regulated firms have an incentive to inflate the value of the rate base (invested capital) or to expand its rate base in order to earn more profit. The Averch-Johnson model (1962) shows that rate-of-return regulation leads the firms to overcapitalize. Specifically, the capital to labor ratio of the regulated firm under a fair rate-of-return constraint will be larger than the one that minimizes costs for the output level that it chooses to produce.<sup>5</sup> The items usually included in the rate base are plant in service less accrued depreciation, construction work in progress (CWIP), plant held for future use and working capital.<sup>6</sup> The identification of the rate base is typically subject to considerable debate. Once the items of the rate base are determined, their valuation must be made. Two methods are generally used for the valuation of the rate base: the original cost method and the fair value method. According to the original cost method, the value of the rate base is the amount actually paid for the rate base at the time of original purchase. The fair value method calculates the value

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<sup>4</sup>Phillips, C.F. (1969) Ch. 8. explains measurement of the rate base in detail.

<sup>5</sup>Baumol and Klevorick (1970), p. 166.

<sup>6</sup>See Cicchetti (1985), and NARUC (National Association of Regulatory Utility Commission) annual reports. In fact, the precise items included in the rate base vary from state to state.

of the rate base in terms of current market value of the capital (rate base).<sup>7</sup> The original cost method is used by a majority of regulatory commissions. The identification and valuation of the rate base is a time-consuming and difficult task in the determination of the revenue requirement.

Fourth, the commission determines the fair rate of return which the firm is allowed to earn on its rate base. The determination of the allowed rate of return is very controversial and is a central issue in rate cases. The commission's determination of the rate of return is very complex and cannot be modelled with any simple formula. A number of financial methods are often suggested in a typical rate case. The commission determination process includes reviews of various arguments and evidence presented by all the parties involved in the rate case, examination of financial, economic and political aspects of the rate request, and many other factors. As described in the preceding chapter, the main subject of the present study is the determination of the commission's allowed rate of return.

Once the allowed rate of return is determined, the earnings of investors can be calculated by multiplying the firm's rate base by the allowed rate of return. These earnings plus the allowable operating costs constitute the revenue required by the firm to provide adequate utility service.

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<sup>7</sup>The valuation method of the rate base is described in detail in Phillips (1969), chapter 8, and Petersen (1981), pp. 224-228.

## 2) The Determination of the Rate Structure

Once the firm's revenue requirement is determined, the next task is to decide how to recover the specified revenue (i.e., how to spread the revenue requirement (RR) over various groups of consumers). Basically, utility prices are set so that  $P_i Q_i = RR$  where  $P_i$  and  $Q_i$  are the prices and quantities of utility services respectively. Fixing the structure of rates for different service classes (i.e., setting  $P_i$ ,  $i = 1 \dots n$ ) is in itself a complex subject and is beyond the scope of the present study.

## 2. The Institutional Procedure of Rate-Making<sup>8</sup>

A regulatory commission has the right to initiate the investigation of rates, revenues and services of regulated firms. In practice, however, the commission generally takes a more passive attitude. The typical rate case starts with the firm's filing of tariff revisions designed to increase its rates, revenues and earnings. Then the commission suspends the proposed rate increase for a period of time (approximately from 90 days to 210 days) and initiates an investigation.

Next, the commission establishes a test period, usually the latest twelve months' period to be used by all parties in the proceeding. The commission staff reviews the data filed by the firm before the hearing process starts. Sometimes if the firm requests emergency rate relief, interim rate increases may be granted and the investigation of the

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<sup>8</sup>This section draws on a review of several actual rate case decisions described in Public Utilities Reports (PUR), 4th series.

remaining portion of the rate increase is continued by the commission. In the meantime, petitions to intervene by any concerned individual, firms, and groups will be reviewed and approved by the commission.

In the hearing process the firm presents the direct and supplemental testimony and exhibits of its witnesses. Cross-examination immediately ensues once each witness presents testimony. The commission staff and intervenors also offer testimony and exhibits. The testimony by the staff often appears to play an important role in the commission decision process. A company's rebuttal testimony is also given at the hearing. After the formal hearing, all parties to the proceeding have an opportunity to file briefs and proposed orders with commissions.

After examining all the evidence the commission issues a notice of decision and order concerning a rate of return on its rate base, approved revenue, and other agenda. Upon this decision on the rate level, the firm is required to file proposed rates and charges design and the commission approves this proposed rates and charges schedule. The commission procedure ends at this stage. Most rate cases take approximately 6 to 10 months. If the firm appeals the commission's decision to the courts, the court review process then begins.

### 3. The Cost of Capital Approach of the Determination of the Allowed Rate of Return in Rate Cases

Usually, the most controversial issue in a rate case is the determination of the firm's allowed (fair) rate of return on its rate base. The legal framework for the determination of the allowed rate of return used by regulatory commissions can be found in the Hope Natural

Gas Company decision issued by the U.S. Supreme Court in 1944.<sup>9</sup> In this case, the Supreme Court stated:

From the investor or company point of view it is important that there be enough revenue not only for operating expenses but also for the capital costs of the business. These include service on the debt and dividends on the stock. . . . By that standard the return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks. That return, moreover, should be sufficient to assure confidence in the financial integrity of the enterprise, so as to maintain its credit and to attract capital.<sup>10</sup>

The Hope decision implies that investors should be granted the opportunity cost of capital which is sufficient to attract capital to investment projects exhibiting the same degree of risk. The regulatory commission, thus, attempts to equate the allowed rate of return with the firm's cost of capital.<sup>11</sup> However, in the absence of any definite rule for determining the cost of capital from legislatures or courts, the regulatory commission may have to rely on various criteria and techniques for calculating the cost of capital to the utility company.

According to the general procedure based on the cost of capital approach, the commission first analyzes the firm's capital structure and determines what portion of its rate base (assets) are funded by

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<sup>9</sup>The Hope decision is an elaboration of the Supreme Court's previous decision in Bluefield case of 1923. See Bluefield Water Works & Improv. Co. V West Virginia Pub. Service Commission, 262 U.S. 679, 692-693 (1923).

<sup>10</sup>Federal Power Commission (F.P.C.) V. Hope Natural Gas Co. 51 (PUR)NS 1944, pp. 200-201.

<sup>11</sup>Since Myer's seminal article (1972), there have been continuous efforts to apply financial techniques to calculate the cost of capital in rate cases.

long-term debt (bonds), by preferred stock, and by common stock.<sup>12</sup> On occasion, the commission may use a hypothetical capital structure rather than the firm's actual capital structure when it believes that the latter doesn't reflect a normal or representative capital structure.

The next step involves the calculation of the cost of each component of the capital structure. Generally, the cost of preferred stock and debt can be computed without much dispute. The return on preferred stock is equal to preferred dividends divided by the book value of preferred stock. The return on debt is equal to interest expenses divided by the book value of debt. These values are referred to as the embedded cost of preferred stock and debt. The most difficult part of the cost of capital calculation is the determination of the cost of equity capital. Once the cost of the each component of the capital structure is determined, the overall cost of capital can be computed by multiplying each capital cost component by its relative weight in the firm's capital structure. This weighted average cost of capital can then be used as an allowed rate of return.<sup>13</sup>

In fact, the determination of a rate of return on equity capital consumes a major portion of the total time and expense in a rate case. There are a variety of methods of calculating the rate of return on

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<sup>12</sup>Since total assets and total liabilities are equal on a firm's balance sheet, its rate base can also be viewed in terms of its liabilities.

<sup>13</sup>However, the determination of the allowed rate of return is not a simple computation of the weighted average cost of capital. This point will be elaborated later.

equity.<sup>14</sup> We will review a few financial methods to measure the rate of return on equity capital used by expert witnesses or staff in rate cases. The review of the financial methods will reveal the incompleteness of the methods and the reasons why the determination of the allowed rate of return is not a process of simple calculation using these financial techniques.

#### 1) The Comparable Earnings Method

According to this traditional method, as suggested in the Hope decision, an expert selects a sample of firms which are considered to be on the same scale of risk comparability after examining capital structures, financial ratios, and many other factors.<sup>15</sup> Once the sample is selected, the expert estimates the rate of return on equity for the sample companies and infers the rate of return on equity of the regulated firm from the estimate of the sample companies.

There are several problems with this method. First, there is the difficulty of defining risk comparability and of selecting the sample of comparable-risk firms. Second, the sample of comparable-risk firms may earn more or less than the cost of equity capital over any given period. Third, comparison of the rate of return between the regulated firm and

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<sup>14</sup> Kolbe, et al., (1984), review the financial techniques in detail.

<sup>15</sup> See, for example, RE South West Gas Corp. 50 PUR 4th (1983), p. 6. Examples of variables considered in this case include ratio of common equity to total capital, annual growth of percent of earnings per share dividend per share growth, fixed-charge coverage, return on equity, dividend payout ratio, and tax account policy.

nonregulated firms, if any, may not be appropriate. Even a regulated firm in one jurisdiction cannot be compared with regulated firms elsewhere since regulatory methods vary so widely from jurisdiction to jurisdiction. Finally, this method does not allow any adjustment for present or anticipated future conditions affecting the firm since it is based entirely on historical data.

## 2) The Discounted Cash Flow (DCF) Method

The DCF concept is frequently utilized to compute the rate of return on equity. The rate of return is simply the discount rate which equates the sum of future cash flows (i.e., dividends) with the present value of the investment (i.e., the price of stock). The formula is:

$$P_0 = \sum_{t=1}^{\infty} \frac{D_t}{(1+r_e)^t} \quad (1)$$

where  $P_0$  = the price of a common stock at the time of purchase

$D_t$  = the expected dividends at year  $t$

$r_e$  = the discount rate, or the rate of return on equity.

If we assume that the future dividends grow indefinitely at the constant rate  $g$ , which is assumed to be less than  $r_e$ , then the formula<sup>16</sup> can be reduced to

$$P_0 = D_1 / (r_e - g) \quad (2)$$

---

<sup>16</sup>The derivation of the formula can be found in most finance texts. See, for example, Weston and Brigham (1979), pp. 372-375.

$$\text{or } r_e = (D_1/P_0) + g \quad (3)$$

where  $D_1$  = the expected dividend at the end of the first  
year ownership

$g$  = the constant growth rate of dividends.

For the rate case presentation, equation (3) can provide a rule of thumb for estimating the rate of return on equity capital.

The DCF method is also subject to challenge on several grounds. First, the strong assumptions of the method are likely to be violated in practice. For example, the assumption of the constant growth rate may not be consistent with reality. Second, the estimation of the growth rate ( $g$ ) may vary significantly depending upon choice of a proxy variable for  $g$ , method used, and data employed. Third, the computation of dividend yield may also vary because of the different values assigned to the dividend and the stock price by the examiners. Therefore, although all parties involved in a rate case use the same DCF formula to compute the  $r_e$ , their results may be quite different.

### 3) The Earning-Price Ratio (EPR) Method

To estimate the cost of equity, the earning-price ratio is sometimes used by experts. This method is, in fact, a variant of the DCF method. The basic formula is :<sup>17</sup>

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<sup>17</sup>The DCF formula (3) and EPR formula (4) are equivalent when  $g = RE/P$  where  $RE$ =retained earnings. This can be shown:  $r_e = E/P = (D+RE)/P = (D/P) + (RE/P) = (D/P) + g$  if  $g = RE/P$ .

$$r_e = E/P \quad (4)$$

where E = book earnings per share

P = the market price of the stock.

This EPR method can be interpreted as a special case of the following formula:<sup>18</sup>

$$P = (E_1/r_e) + PVGO \quad (5)$$

where  $E_1$  = book earnings per share under a no growth policy (i.e., under  $g = 0$  or  $RE = 0$ )

PVGO = the present value of growth opportunities.<sup>19</sup>

The earning-price ratio, therefore, is:

$$E_1/P = r_e [1 - (PVGO/P)] \quad (6)$$

Although the EPR method is easy to compute, it suffers from serious problems. From the above equation (6), we can see that the EPR will, in fact, underestimate  $r_e$  if PVGO is positive and overestimate it if PVGO is negative. The EPR is equivalent to  $r_e$  only if PVGO = 0, and only if earnings per share (E) is the average future earnings the firm could generate under a no-growth policy ( $g = 0$ ). Since this strong assumption is hardly satisfied in reality, the EPR can not be a reliable estimate of  $r_e$ . In addition, the book or accounting earnings is not a good measure of true earning since it depends on arbitrary choices of accounting methods, inflation problem, and many other factors.

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<sup>18</sup> See Brealey and Myers (1981), pp. 52-56.

<sup>19</sup> The calculation of PVGO can be found in Brealey and Myers (1981), pp. 54-56.

#### 4) The Capital Asset Pricing Model (CAPM) Method

The CAPM is a relatively new method of estimating the cost of equity capital, which is derived from a theoretical model that associates return on equity capital with its risks. The theory asserts that a high risk investment should be rewarded with a high average rate of return, and a low risk investment with low average rate of return. The rate of return can be calculated by the following equation.

$$r_e = r_f + \beta(r_m - r_f) \quad (7)$$

where  $r_e$  = the expected rate of return on equity capital

$r_f$  = risk-free rate of return

$r_m$  = the expected market rate of return

$\beta$  = the beta coefficient, a measure of risk.<sup>20</sup>

That is, a potential investor will require an expected return equal to the risk free rate of return plus a risk premium for investing in a risky stock.

Although the CAPM is generally regarded as a theoretically consistent model, it is also subject to criticism with regard to both

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<sup>20</sup>The beta of asset  $j$  with respect to the market portfolio is defined as  $\beta_j = \text{Cov}(r_j, r_m) / \text{Var}(r_m)$  where  $r_j$  = the market return on asset  $j$ ,  $r_m$  = the rate of return on the market. In practice, beta is estimated by running a regression of stock return on market returns. The estimated slope coefficient from this regression is a measure of beta. There is the risk premium (RP) method, which can be considered a traditional and simple version of the CAPM. In the RP method  $\beta$  is not required. In fact, the risk premiums can be found by calculating the selected firm's average differences between the actual rate of return on common stock and the rate of return on long-term government bonds.

the model itself and its applications. There still exist other risk factors that beta cannot capture when the market is not in equilibrium since equation (7) strictly holds only when the market is in equilibrium. Also, as practical matter, it is very difficult to find reliable estimates of the beta and the market rate,  $r_m$ . The beta and the market rate estimated from the historical data are most likely to differ from the true values substantially. Even if they are estimated with precision, they may be changing over time. The study by Breen and Lerner (1972) advised caution in the use of beta in regulatory cases and pointed out that empirical measures of beta can vary depending upon the estimating equation used, the choice of market index, and the specific time period selected.

So far we have reviewed several financial methods of estimating the cost of equity capital and thus the allowed rate of return. As we have seen, none of those methods avoids serious problems. In general, all methods suffer from some violation of the assumptions, the subjective use of historical data, and impossibility of accommodating unpredictable factors. The estimate obtained from historical data may not reflect the expected rate of return, which could, in fact, be influenced by a host of factors -- expected economic environment, expected regulatory policy, investor's attitudes toward risk, inflation, the firm's management policy and so on. In fact, it is almost impossible to estimate the opportunity cost that investors expect to earn. The regulator, therefore, has no way of knowing what rate of return investors actually expect in the stock market.

Because of the difficulties involved in estimating the cost of equity capital, there is no universally accepted method that may be consistently and dispassionately applied in a rate case.<sup>21</sup> Since the parties in a rate case usually use different methods, the results differ significantly. Even if they use the same techniques, the result may not be the same, depending on the data used, the period covered, and adjustments made. Thus, parties in a rate case rarely agree on the method and the calculation of the appropriate rate of return. Consequently, regulators almost inevitably have to weigh the arguments of various witnesses and compromise the conflict of interests of various parties. Although expert witnesses may make a conscientious effort to calculate the allowed rate of return using the cost of capital approach, the commission's determination of the allowed rate of return is "necessarily a matter of judgement and can not be reduced to a fixed formula."<sup>22</sup> Since we know that the rate making process is not an exact science, it also seems that the commission's judgment may be not only discretionary but susceptible to influences from various interested parties, particularly the regulated firm.

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<sup>21</sup>In the Hope decision (1944), the U.S. Supreme Court stated that the commission was not bound to the use of any single formula or combination of formulae in determining rates.

<sup>22</sup>RE Southern California Edison Co. 50 PUR 4th, p. 378.

### CHAPTER III

#### LITERATURE REVIEW

##### 1. The Determination of the Allowed Rate of Return

Joskow (1972) first attempted to explain how a regulatory commission determines the allowed rate of return. He conjectured that the basic factors the commission takes into consideration in determining the rate of return include (a) the presentation of the firm, (b) the argument of intervenors, (c) its own judgement concerning the characteristics of the case, and (d) the performance characteristics of the firm. He then specified these factors into quantifiable variables.

The presentation of the firm is represented by two variables in Joskow's model, the rate of return requested by the firm ( $R_f$ ) and a dummy variable indicating whether or not the firm presented testimony on the cost of capital (T).<sup>23</sup> The presentation of the cost of capital testimony may improve the credibility of the firm's rate of return request, give the commission more information, and thus increase the likelihood that the firm's requested rate of return is not discounted by the commission. To represent the presentation of intervenors a variable V is used. Instead of using a simple binary variable an attempt is made to capture the extent of conflict between the firm and intervenor by specifying that when there is no intervenor's testimony the variable V

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<sup>23</sup>In more recent rate cases, almost all firms present cost of capital testimony, and thus the lack of variation in this variable is likely to make its inclusion in the current study unnecessary.

takes on value zero and otherwise it equals  $[1 - (R_v/R_f)]$ , where  $R_v$  is the rate of return suggested by the intervening party. The lower the value of the intervenor's suggested rate of return ( $R_v$ ) relative to the requested rate of return ( $R_f$ ), the higher the value of this variable  $V$ , and vice versa.

Regarding the judgment of the commission two variables are introduced. A dummy variable  $GED$  is used to distinguish gas rate cases from electric rate cases as the two may receive different regulatory treatment. A gas company may request higher rate due to a relatively high risk premium and, therefore, the commission may discount gas company requests more than electric company requests. The other variable representing the judgment of the commission is the positive residuals computed from the firm request equation (which will be described later),  $\hat{u}_2$ . An above average residual may indicate that the firm is aggressive, and thus the request of the aggressive firm will be discounted more by the commission and vice versa. To represent the performance characteristics of the firm a dummy variable for the efficiency of the firm,  $E$ , is included. This variable is also very subjective. If the commission has commended a firm for its efficiency or service, it is treated as an efficient firm and  $E$  equals one. Otherwise,  $E$  assumes a value of zero.

Thus, the equation for the allowed rate of return granted by the commission is summarized:

$$S = b_0 + b_1 R_f + b_2 T + b_3 V + b_4 GED + b_5 \hat{u}_2 + b_6 E + u_1 \quad (1)$$

where  $S$  = the rate of return allowed by the commission

$R_f$  = the rate of return requested by the firm

$T = 1$  if the firm presents testimony on the cost  
 of equity capital and 0 if it does not  
 $V = 0$  if there is no intervenor presenting rate of  
 return testimony and  $(1-R_V/R_f)$  otherwise  
 $GED = 1$  if the request is from a gas company and  
 0 if the request is from an electric company  
 $\hat{u}_2$  = the positive residuals calculated from equation (3) below  
 $E = 1$  if the efficiency of the firm is commended by  
 the commission and 0 otherwise  
 $u_1$  = the error term.

In addition to the commission decision equation (1), the firm request equation is also specified in Joskow's (1972) study. The firm's requested rate of return is determined by two considerations: calculation of a cost of capital and adjustments in the calculation of the cost of capital to account for certain characteristics of the firm. The equation for the firm's requested rate of return is:<sup>24</sup>

$$R_f = \delta_0 + \delta_1 C_1 + \delta_2 C_2 + \delta_3 GED_1 + \delta_4 OOD + u_2 \quad (2)$$

where  $C_1$  = the imbedded cost of debt

$C_2$  = the cost of equity capital

$GED_1 = 1$  when the request is from a gas department  
 of a combination company and 0 otherwise

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<sup>24</sup> $C_1$  and  $C_2$  are the overall (weighted average) cost of capital computation components while  $GED$ , and  $OOD$  are adjustment components.

OOD = 1 when the request is from a firm without  
its own capital structure and 0 otherwise

$u_2$  = the error term.

In actual estimation of the above equation (2) the variable  $C_2$  is dropped since data for the firm's estimate of the cost of equity capital in a regulatory hearing may not be a pure estimate of the true cost of equity capital but, instead, already includes some adjustments. The firm request equation, then, is:

$$R_f = a_0 + a_1 C_1 + a_2 GED_1 + a_3 OOD + u_2 \quad (3)$$

Equations (1) and (3) establish the behavioral model of the determination of the allowed rate of return in the form of a two-equation recursive system:

$$S = b_0 + b_1 R_f + b_2 T + b_3 V + b_4 GED + b_5 \hat{u}_2 + b_6 E + u_1 \quad (1)$$

$$R_f = a_0 + a_1 C_1 + a_2 GED_1 + a_3 OOD + u_2 \quad (3)$$

$$\text{where } E \begin{bmatrix} U_1 \\ U_2 \end{bmatrix} \begin{bmatrix} U_1 & U_2 \end{bmatrix} = \begin{bmatrix} \sigma_1^2 I & 0 \\ 0 & \sigma_2^2 I \end{bmatrix}$$

$$E(U_1 U_1') = \sigma_1^2 I, \quad E(U_2 U_2') = \sigma_2^2 I$$

The data employed by Joskow consist of twenty rate cases decided by the New York State Public Service Commission during the period 1960-1970. The expected signs of  $\hat{a}_1$ ,  $\hat{a}_2$ ,  $\hat{b}_1$ ,  $\hat{b}_2$  and  $\hat{b}_6$  were positive,

and those of  $\hat{a}_3$ ,  $\hat{b}_3$ ,  $\hat{b}_4$  and  $\hat{b}_5$  were negative.<sup>25</sup> The coefficient  $\hat{b}_1$  was hypothesized to be between zero and unity since the commission is not expected to allow the full amount of a firm's incremental request. The estimation results using OLS yielded coefficients that had all the expected signs. Moreover, all coefficients except  $\hat{a}_3$  and  $\hat{b}_6$  were statistically significant at the 5 percent level.

One unexpected result was that, contrary to the expectation, the estimated coefficient of  $R_f$  was 1.1. Joskow's explanation for this was that the commission may allow a higher rate than the requested rate of the firm to make up losses from regulatory lag if a regulatory hearing process is in the period of rapid inflation. To test this "inflation premium" hypothesis, Joskow divided his observations into two groups, inflationary and noninflationary, and ran the equation  $S = f(R_f, \hat{u}_2)$  for each group. The estimation results showed that the coefficient of  $R_f$  of inflationary group is greater than that of the noninflationary group. Despite the small sample size (20 observations) and unavailability of appropriate data for the pure cost of equity capital (which led to eventual omission of the variable  $C_2$ ), this simplified model of the determination of the allowed rate of return provides a basis for further study of the regulatory decision process.

In a related paper Joskow (1973) specified and estimated a behavioral model of the decision rule of a regulated firm to apply to

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<sup>25</sup>The negative expected sign of  $\hat{a}_3$  may not hold, however, if the cost of capital testimony is based on the capital structure of a very stable parent company and, therefore, the firm may not have to make a downward adjustment of the requested rate of return.

the regulatory commission for a rate increase or a voluntary rate decrease. The firm decision function for whether or not to request a rate increase was specified by a probit model:

$$P(INC=1) = P(I_k > \bar{I}_k), \bar{I}_k \sim N(0, 1), \text{ and}$$

$$I_k = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 P_s \quad (4)$$

where  $P(INC=1)$  = the probability that a rate increase  
will be filed by a firm<sup>26</sup>

$INC = 1$  if an increase is filed by a particular  
firm each year (if  $I_k > \bar{I}_k$ )  
= 0 otherwise (if  $I_k \leq \bar{I}_k$ )

$I_k$  = decision index for a rate increase

$\bar{I}_k$  = threshold value for a rate increase

$X_1$  = growth rate in earning per share

$X_2$  = growth rate in earning per share

lagged one period

$X_3$  = interest coverage ratio<sup>27</sup>

$P_s$  = (earned rate of return / rate of return  
allowed in most recent rate case).

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<sup>26</sup>The probability can be calculated by the cumulative normal  
probability function:

$$\frac{1}{\sqrt{2\pi}} \int_{-\infty}^{I_k} e^{-u^2/2} du$$

<sup>27</sup> $X_3$  = gross income before income taxes/total interest charges.

In specifying the firm increase decision equation ( $I_k$ ), most variables are financial variables that the firm and commission have identified as being important in the decision process. In addition, the perception variable ( $P_s$ ) is included in the equation (4) to represent the firm's perception of the chances of getting a rate increase approval by the commission.

The probit model for the firm decrease decision is also specified:

$$P(\text{DEC}=1) = P(D_k > \bar{D}_k), \bar{D}_k \sim N(0, 1), \text{ and}$$

$$D_k = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 P_D \quad (5)$$

where  $P(\text{DEC}=1)$  = the probability of filing a voluntary  
price decrease<sup>28</sup>

$\text{DEC} = 1$  where a voluntary decrease is made each  
year (if  $D_k > \bar{D}_k$ )

= 0 otherwise (if  $D_k \leq \bar{D}_k$ )

$D_k$  = the probit index for the firm decision  
to decrease a rate voluntarily

$\bar{D}_k$  = threshold value for a rate decrease

$P_D$  = (earned rate of return / the highest  
rate of return allowed for a comparable  
utility in the previous period).

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<sup>28</sup>The probability is computed by the same cumulative density function:

$$\frac{1}{\sqrt{2\pi}} \int_{-\infty}^{D_k} e^{-u^2/2} du$$

The probability of the "do nothing" is computed:  
 $P(\text{NOTH}=1) = 1 - P(\text{DEC}=1) - P(\text{INC}=1)$ .

The probit decrease decision equation ( $D_k$ ) also used the same financial variables,  $X_1$  and  $X_2$ . The variable  $P_D$  stands for the firm's perception of the chances of being forced to reduce price by a regulatory commission.

Joskow estimated equations (4) and (5) using the maximum likelihood method with data consisting of 63 annual observations on seven major utilities in New York State for the period 1961-1969. The predicted signs of the coefficients in equation (4) are all negative since healthy financial condition of the firm (represented in variables  $X_1$ ,  $X_2$ , and  $X_3$ ) and a low chance of obtaining a rate increase approval (contained in variable  $P_s$ ) will discourage the firm from filing a rate increase request. The anticipated signs of the coefficients in equation (5) are all positive since sound financial position (represented in variables  $X_1$  and  $X_2$ ) and a high probability of inviting action by the commission to have prices reduced (revealed in variable  $P_D$ ) will lead the firm to reduce its rates voluntarily. The estimation results showed that all the coefficients in equations (4) and (5) had the expected signs and all but one were significant at the 5 percent level (the coefficient of the interest coverage ratio variable was significant at the 10-percent level).

In summary, Joskow's results indicated that the firm decision to file for a rate increase is dependent on the growth rate of earnings per share in the current and previous year, on the level of interest coverage, and on the firm's perception of the likelihood of success in filing a rate increase. The decision to file a voluntary rate decrease was shown to be influenced by the growth rate in earning per share and

the level of the firm's perception of the likelihood of a "forced" reduction.

Based on the preceding two papers by Joskow (1972 and 1973), Roberts, Maddala, and Enholm (1978) further analyzed the firm's equation for the requested rate of return and the commission's equation for the allowed rate of return by examining the problems of selectivity and simultaneity present in the Joskow's four equations. The problem of selectivity occurs since the equation for whether or not to request a rate increase (equation (4)) is related to the equation for how much to request (equation (3)). That is, a firm would decide to go for a rate increase only if an increase in profit obtainable from a rate case is greater than the costs of preparing the case. Thus how much to request is related to whether or not to request a rate increase. The simultaneity problem arises since the error term in the equation for the rate of return granted by commission (equation (1)) is correlated with the error term in the equation for the rate of return requested by the firm (equation(3)). Namely, how much of an increase the firm expected to receive is related to how much the firm requests. To account for both problems they developed both a "probit two-stage least squares (probit 2SLS) model" and a "tobit two-stage least.squares (tobit 2SLS) model", and estimated the following specific functional forms using the above two models respectively:

$$R_f = \gamma_0 + \gamma_1 C_1 + \gamma_2 (ROR_L - ROR_e) + u_1 \quad (6)$$

$$S = \delta_0 + \delta_1 R_f + \delta_2 (ROR_e - ROR_L) + u_2 \quad (7)$$

where  $C_1$  = the embedded cost of capital

$ROR_L$  = the last rate allowed by the commission

$ROR_e$  = the currently earned rate of return by the firm.

Substitution of (6) into (7) produces the reduced form below:

$$S = (\delta_0 + \delta_1\gamma_0) + \delta_1\gamma_1C_1 + (\delta_2 - \delta_1\gamma_2)(ROR_e - ROR_L) + \delta_1u_1 + u_2 \quad (8)$$

In specifying the above equations Roberts, et al. (1978) omitted the dummy variables Joskow used in equations (1) and (3) since the data for the variables such as  $R_I$ ,  $E$ ,  $T$  were not available and the dummy variables like GED and OOD are unnecessary if the sample firms are electric utilities. They attempted to introduce a strategy variable which represents the dynamic interaction between the commission and firm regarding the requested rate and allowed rate by introducing the variable  $(ROR_L - ROR_e)$ . The data included a total of 59 observations for four electric utilities in Florida over the period 1960 to 1976.

The empirical results from the tobit 2SLS estimation proved to be meaningful.<sup>29</sup> All the coefficients including the strategy variables in the equations (6) and (7) were significant. The sign of  $\gamma_2$  in equation (6) was negative, which suggests that firms earning a rate of return higher than the last one allowed by the commission will increase their request, ceteris paribus. This implies that the behavior of the firms was, in fact, aggressive. The sign of  $\delta_2$  in equation (7) was also negative, which indicates that the commission will discount the inflated

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<sup>29</sup>However, the results from the probit 2SLS model were not satisfactory.

requests of aggressive firms. Finally the coefficient ( $\delta_2 - \delta_1\gamma_2$ ) in equation (8) was not significantly different from zero, which means that the ultimate decision of the commission may be based solely on the embedded cost of capital, not on the performance of the firm.

In another paper, Hagerman and Ratchford (1978) attempted to identify some factors which influence the regulatory commission's determination of the allowed rate of return on equity of electric utilities. They hypothesized two types of variables affecting the regulators' decision concerning the allowed rate of return: economic variables and political variables. Five economic variables were selected. The  $\beta$  coefficient in the capital asset pricing model and the debt to equity ratio were used to represent a measure of risk. Both variables were hypothesized to be positively related to the allowed rate of return. The third economic variable is asset size as a proxy for the size of firm. The expected sign of the asset size is indeterminate in the context that big firms may have greater expertise in dealing with regulators but may be exposed to greater public pressure. The fourth variable is whether the commission uses the book value method or the fair value method in the determination of the rate base. The commissions using the fair value method were hypothesized to grant lower rates of return than those using the book value (original cost) method. The last economic variable is the interest rate which was expected to be positively associated with the allowed rate of return. Three different interest rates were used: rates of 90-day Treasury bills, long-term AAA utility bonds, and AAA corporate bonds.

Four "political" variables were used. The first variable was the compensation of the commissioners. If the compensation is high, the desire to retain the job is high. This may lead to granting lower rate of return to avoid the public pressure. Thus the expected sign is negative. The second political variable is the term of the commissioners which was expected to be positively related to the allowed rate of return since the long term provides less public pressure and greater job security. The third variable is whether the commissioners are appointed or elected. Elected commissioners were expected to grant lower allowed rates since they are likely to favor the public. The last political variable is the number of commissioners. The expected sign was positive on the presumption that the larger the number of commissioners the smaller the responsibility of each commissioners.

A total of 79 observations on electric utilities from 33 states was covered in their data set. The estimation technique they used is a error-components model to distinguish a random effect associated with each state from the effect associated with observations within each state:

$$S_{ij} = a + b_1 X_{1ij} + b_2 X_{2ij} + \dots + b_m X_{mij} + e_{ij} \quad (9)$$

$$\text{where } e_{ij} = u_i + v_{ij}$$

$$u_i \sim N(0, \sigma_u^2) = \text{error term associate with state } i$$

$$v_{ij} \sim N(0, \sigma_v^2) = \text{error term associated with}$$

observation  $j$  in state  $i$

$$\text{Cov}(u_i, v_{ij}) = \text{Cov}(u_i, u_k) = \text{Cov}(v_{ij}, v_{kl}) = 0$$

$$S_{ij} = \text{the allowed rate of return associated with}$$

observation  $j$  in state  $i$

$X_{ij}$  = the independent variables(described above).

The regression was run three times by using three different interest rates as one of the independent variables. The empirical results showed that all coefficients of the economic variables had the expected signs. Moreover, except for the  $\beta$  coefficient variable, they are statistically significant at the 5-percent level. As for the political variables, the only statistically significant variable with the correct expected sign was the term of the commissioners. The other political variables, the compensation and number of commissioners, and whether or not they were elected or appointed, were insignificant and had wrong signs.

## 2. The Economic Theory of Regulation

The literature on the theories of economic regulation<sup>30</sup> provides some insights in the study of the determination process of the allowed rate of return of the regulatory commission. Stigler's theory of economic regulation is mentioned as one of the explanations for the reason why regulation is instituted.<sup>31</sup> Stigler (1971) contends that "as a rule regulation is acquired by the industry and designed and operated

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<sup>30</sup>Posner, Richard A. (1974) elaborates several versions of the theory of economic regulation.

<sup>31</sup>There are two frequently cited versions of the economic theory of regulation: The "public interest" theory argues that regulation is instituted to protect the public interests: the "capture" theory contends that over time regulatory agencies become dominated (captured) by the regulated firms or interest groups. There are others. See Owen and Braeutigam (1978), pp. 9-31.

primarily for its benefits."<sup>32</sup> Since regulated firms see the possibilities for increasing their profits by using the "coercive" power of government, there exist incentives for utilizing that power. As mentioned by Stigler, the benefits of governmental regulation can take several forms -- direct subsidy, control of entry by new firms, control of substitute and complementary goods, direct price control and so on. The industry seeks these benefits through government regulation. The presence of the incentives for firms or any interest group to maximize their profit or economic interest leads to the demand for regulation.

As regulation is conceived as a good demanded by buyers belonging to effective interest groups, it can be also viewed as a product supplied by sellers, the regulatory authorities. While regulation provides valuable benefits to particular interest groups or individuals, the supply of regulation costs them various resources. Since the sellers are also driven by self-interest, they may attempt to maximize either votes, wealth, or utility depending on their own interest.<sup>33</sup> Thus the buyers of the regulatory product may have to pay the cost of regulation in a variety of forms -- campaign contribution, votes, political advertising, employment opportunities for retired commissioners, cash bribes, extraordinarily expensive treatment, etc.

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<sup>32</sup>Stigler (1971), p. 3.

<sup>33</sup>Peltzman (1976) contends that politicians or regulators maximize their vote margins and supply regulatory benefits to the groups that provide these vote margins.

As an outcome of the interaction between supply and demand, regulation will be supplied to the economic groups which value it the most and pay the highest price.

The economic theory of regulation implies that the regulators' behavior can be influenced by the firms they regulate. Changes in regulatory outcomes resulting from the rent-seeking behavior of the regulated firm may be found in state regulatory commission regulation. For example, the regulated firm may obtain a higher allowed rate of return from the regulatory commission as it increases its effort to secure a higher rate of return through various means, e.g. increased expenditure on the regulatory hearing process.

## CHAPTER IV

### DETERMINATION OF THE ALLOWED RATE OF RETURN IN STATE

#### REGULATORY COMMISSIONS: THE IMPACT OF REGULATORY

#### EXPENSES ON THE REGULATORY HEARING PROCESS

##### 1. Introduction

The determination of the allowed rate of return may be viewed as an outcome which encompasses compromise of the interests of conflicting parties involved in rate cases. Although the final decision is reached solely by the regulatory commission, its decision process involves dynamic interactions among all concerned parties. As we have seen in the institutional setting of state regulatory commissions, the commission decision is normally based upon the recommendation of its staff, testimonies of the firm and intervenors, its own characteristics, and its own judgment regarding other economic and political considerations. State commissions may be exposed to various influences from the above parties within a formal rate case. In addition it is also possible for the commissions to be affected by the concerned parties outside the formal rate case as well.

Firms are also subject to change in policies or decisions of the state regulatory commissions. It is unassailable that regulated firms' profits are influenced by the regulatory commission. The firm's decisions are also affected by the commission staff as well as intervenors, whose courses of actions are also influenced by the behaviors of the firm. It appears, then, that the behavior of the commission, the firm, the staff, and intervenors are all intertwined.

It is of some interest to examine how the regulated firm, commission's staff, intervenors, and the regulatory commission are interrelated in the regulatory process. The regulatory commission's determination process of the allowed rate of return can exhibit certain aspects of the relations among parties involved in a rate case.

This study attempts to find evidence that regulatory commissions are influenced by regulated firms. It is recognized in this study that regulatory expenses can serve as a key variable measuring the intensity of the firm's attempt to influence the decisions of the commissions and their staffs. Although there may be many factors affecting the consequences of rate cases, one quantifiable variable indicating whether the regulatory consequences are influenced by certain parties may be the regulatory expenses. Accordingly, the study will also focus on the impact of regulatory expenses on the regulatory outcome, especially on the allowed rate of return.

The scope of this study will be limited to the state regulatory commissions' determination of the allowed rate of return on equity capital of investor-owned electric utilities. The reason for limiting the study to electric utilities can be found in the difficulty of obtaining data. For example, data for the regulatory expenses of gas utilities are not available. And the reason for examining the rate of return on equity capital rather than overall rate of return on capital is that differences in calculation of overall rate of return are mostly due to discrepancies in computation of the rate of return on equity due to the absence of any fixed formula for determining the rate of return on equity.

In this chapter we model the determination of the allowed rate of return on equity capital by capturing actual rate case processes in state regulatory commissions. Three equations which consist of a system of equations will be introduced. In addition to Joskow's commission decision equation and firm request equation, a staff recommendation equation is added to the system. The commission staff is treated as an independent party rather than as part of the commission since the commission typically considers the staff as one of the intervenors in the rate case. Although an intervenor equation could also be specified to constitute a complete system, the intervenor equation is omitted because of a lack of knowledge of the decision process of numerous and heterogeneous intervenors and an absence of available data.

In the next section the endogeneity of the allowed rate of return and its implications are discussed. In section 3 the three empirical equations are specified and their estimation technique is mentioned. In the fourth section, a description of data including collection procedures and sources of the data is provided. In section 5 empirical results are discussed. In the sixth section a brief summary and conclusion are presented.

## 2. The Endogeneity of the Allowed Rate of Return

The economic theory of regulation implies that a regulated firm is able to change regulatory outcomes by influencing the decision making process of a regulatory commission. If the firm, in fact, influences the regulator, it will incorporate the commission decision process into its decision making, and thus commission regulation becomes endogenous

to the firm's decision making process. Thus endogenous regulation can provide an insight into the behavior of both the regulated and the regulator.

Specifically, we will examine the firm's behavioral implication derivable from the assumption of the endogeneity of the allowed rate of return. It is assumed that the commission decision process for determining the allowed rate of return is influenced by the firm's regulatory expenditures.

The simple A-J type model is reformulated by addition of the regulatory expenses (E) and incorporation of the determination equation of the allowed rate of return (S) into the model.

A regulated firm seeks to maximize its profits

$$\begin{aligned}\pi &= P(Q)Q(K,L,F) - wL - fF - rK - E \\ &= R(K,L,F) - wL - fF - rK - E\end{aligned}\tag{1}$$

subject to a regulatory constraint<sup>34</sup>

$$\begin{aligned}\{[R(K,L,F) - wL - fF] / K\} &\leq S(E,X) \\ \text{or } R(K,L,F) - wL - fF - S(E,X)K &\leq 0, \quad \text{for } S > r\end{aligned}\tag{2}$$

where P = the price of the firm's output

P = P(Q): the inverse demand function

Q = the firm's output

Q(K,L,F) = the production function

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<sup>34</sup>The firm is constrained such that the earned rate of return on capital cannot exceed a certain rate of return allowed by the regulatory commission (S). Since S is assumed to be functionally related to E (a control variable), the regulatory "constraint" becomes endogenous in this model.

$R(K,L,F) = PQ$ : the firm's total revenue function

$L$  = the amount of labor employed by the firm

$F$  = the amount of fuel used by the firm

$K$  = the amount of capital employed by the firm

$w$  = the wage rate

$f$  = the price of fuel

$r$  = the cost of capital

$S$  = the allowed rate of return set by the regulatory  
commission

$E$  = the regulatory expenses of the firm

$X$  = a vector of exogenous variables on which the  
regulatory commission's decision is based.

If the regulatory constraint is assumed binding and thus to hold as an equality, the regulated firm's constrained profit maximizing problem can be solved by using the classical Lagrangian method. The Lagrangian function can be defined as:

$$G(K,L,F,E,\lambda) = R(K,L,F) - wL - fF - rK - E - \lambda[R(K,L,F) - wL - fF - S(E,X)K] \quad (3)$$

Assuming that  $K > 0$ ,  $L > 0$ ,  $F > 0$ ,  $E > 0$ , and  $0 < \lambda < 1$ ,<sup>35</sup> the first-order conditions are:<sup>36</sup>

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<sup>35</sup>Baumol and Klevorick(1970) showed that  $0 < \lambda < 1$ .

<sup>36</sup>Since the regulatory constraint is assumed to be effective, the Kuhn-Tucker conditions are not necessary. See Takayama (1969).

$$R_K - r = \lambda[R_K - S(E,X)] \quad (4)$$

$$R_L = w \quad (5)$$

$$R_F = f \quad (6)$$

$$\lambda \frac{\partial S}{\partial E} K = 1 \quad (7)$$

$$R(K,L,F) - wL - fF - S(E,X)K = 0 \quad (8)$$

where  $R_K$ ,  $R_L$ , and  $R_F$  are partial derivatives of  $R(K,L,F)$  with respect to  $K$ ,  $L$ , and  $F$  respectively.

The second-order conditions require a positive value for the bordered Hessian, i.e.,

$$H = \begin{vmatrix} (1-\lambda)R_{KK} & (1-\lambda)R_{KL} & (1-\lambda)R_{KF} & \lambda(\partial S/\partial E) & -[R_K - S(E,X)] \\ R_{LK} & R_{LL} & R_{LF} & 0 & 0 \\ R_{FK} & R_{FL} & R_{FF} & 0 & 0 \\ \lambda(\partial S/\partial E) & 0 & 0 & \lambda(\partial^2 S/\partial E^2)K & (\partial S/\partial E)K \\ R_K - S(E,X) & R_L - w & R_F - f & -(\partial S/\partial E)K & 0 \end{vmatrix} > 0$$

where notationally  $R_{KK} = \frac{\partial^2}{\partial K^2} R(K,L,F)$ ,  $R_{KL} = \frac{\partial^2}{\partial K \partial L} R(K,L,F)$ , etc.

The value of the bordered Hessian (after expanding the determinants) is:

$$\begin{aligned} H = & \{ \lambda K (\partial^2 S/\partial E^2) (R_K - S(E,X))^2 (R_{LL}R_{FF} - R_{FL}R_{LF}) \} \\ & + \{ 2\lambda K (\partial S/\partial E)^2 (R_K - S(E,X)) (R_{LL}R_{FF} - R_{LF}R_{FL}) \} \\ & + \{ (1-\lambda)K^2 (\partial S/\partial E)^2 (R_{KK}R_{LL}R_{FF} + R_{LK}R_{FL}R_{KF} + R_{KL}R_{LF}R_{FK} - R_{KF}R_{LL}R_{FK} \\ & - R_{KL}R_{LK}R_{FF} - R_{KK}R_{LF}R_{FL}) \} > 0 \end{aligned}$$

It is found from equation (7) that  $\frac{\partial S}{\partial E} > 0$  since  $0 < \lambda < 1$  and  $K > 0$ .<sup>37</sup>  $\frac{\partial S}{\partial E} > 0$  implies that the regulatory commission allows a higher rate of return to the firm with greater regulatory expenditures.<sup>38</sup> In addition to this implication, there is an incentive for the regulated firm to increase the regulatory expenses to obtain a higher allowed rate of return. The regulated firm will increase its regulatory expenses so long as the marginal benefit from the resulting increased allowed rate of return is greater than the marginal cost. This also implies that the firm can find the optimum level of regulatory expenditures. In the next section, the empirical model of the determination of allowed rate of return is developed while incorporating the testable proposition ( $\frac{\partial S}{\partial E} > 0$ ) into the model.

### 3. Empirical Model

#### 1) The Firm Request Equation

The rate of return on equity which a regulated firm requests will be based on the firm's calculation of the cost of equity plus several

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<sup>37</sup> The decision regarding whether the regulatory expenditures (E) are allowable expenses requires judgement from the regulatory commission in a rate case. If E is an allowable item, the regulatory constraint (2) should be rewritten as  $R(K, L, F) - wL - fF - E - S(E, X)K \leq 0$ , for  $S > r$ . This will change the first-order conditions (7) and (8) into  $\lambda[1 + (\partial S / \partial E)K] = 1$ , and  $R(K, L, F) - wL - fF - E - S(E, X)K = 0$  respectively. However, the primary result,  $\partial S / \partial E > 0$ , still holds true since  $(\partial S / \partial E)K = (1/\lambda) - 1 > 0$ .

<sup>38</sup> However, from the calculated value of the Hessian, it is found that the sign of  $\partial^2 S / \partial E^2$  is indeterminate.

other factors. A very general specification of a model of the firm's requested rate of return on equity can be specified as follows:

Firm's requested rate of return = f (dividend yield, risk, interest rate, regulatory climate, regulatory expenditure intensity, currently earned rate of return, previously allowed rate of return).

The dividend yield will be used as a proxy for the cost of equity capital since the discounted cash flow (DCF) method is a commonly used method in rate cases.<sup>39</sup> In addition, several other explanatory variables are included in the firm request equation.

First, if investors perceive a firm as risky, the cost of attracting necessary capital becomes more expensive. Accordingly, the firm has to provide a high rate of return. That is, if the firm is risky, it is likely to adjust its requested rate of return upward. As a proxy variable for the firm's risk, the debt to equity ratio will be used. When the firm relies more on debt financing, its financial risk increases. It is expected, therefore, that high debt to equity ratio is positively associated with the firm's requested rate of return.

Second, utility companies, like any other firms, are also competing to attract the necessary funds in capital markets. The interest rate may provide firms with an approximate figure for what level of rate of

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<sup>39</sup> According to the DCF method, the cost of equity is the dividend yield plus the expected growth rate of dividend. However, the expected growth rate of dividend component is omitted in the firm request equation due to difficulty of obtaining reliable data.

return investors require. Thus the interest rate is also included in the equation to represent a market cost of capital prevailing in financial markets. Since utilities have to provide at least a prevailing market interest rate to investors, the expected sign of the interest rate in the firm request equation should be positive. The interest rate on AAA utility bonds at the month of filing the rate case will be used.

Third, the regulatory climate may be one of the factors the firm considers in determining the requested rate of return on equity. Some state regulatory commissions may be favorable towards firms. Others may be hostile. Examples of factors constituting unfavorable regulatory climate include lengthy regulatory lag, exclusion of construction work in progress (CWIP) from the rate base, no fuel adjustment clause, use of a historical test year rather than a forward-looking test year, the use of original cost rate base rather than fair value rate base, low allowed rate of return, inconsistent regulatory policies, etc. Investors may shy away from the stock of firms which operate in hostile state regulatory environments. As a result, firms operating under hostile commissions may have to offer a high rate of return to obtain needed capital. Less favorable regulatory environment can be regarded as a regulatory risk. Several studies show that unfavorable regulatory environment increases the cost of capital to utilities.<sup>40</sup> However, if the regulatory commission is hostile, the firm knows that the commission

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<sup>40</sup>These studies are Trout (1979), Archer (1981), Dubin and Navarro (1983), and Fanara and Gorman (1986).

will not allow a high rate of return. Recognizing this predicted action of the commission, the firm may not request a higher rate of return to prevent an excessive discount from the commission. This consideration thus leads the expected sign of the regulatory climate variable to be indeterminate. Raw rankings of the state regulatory commissions published by the Salomon Brothers Inc. will be used as a variable representing the regulatory climate.<sup>41</sup> The most favorable regulatory commission is treated as 1 and the least favorable commission as 10.

Fourth, so long as state commission regulation is effective, the allowed rate of return is maintained below the monopoly rate of return, which could be achieved in the absence of regulation. Thus the profit-maximizing firm will not cease in its attempt to obtain a higher allowed rate of return since it can still increase its profits by obtaining the higher allowed rate of return. This incentive to improve its profits naturally leads the firm to increase its regulatory expenses. As the regulatory expenses increase, the firm is likely to request a high rate of return to recover the regulatory expenses. It is likely for firms to request a high rate of return as long as the regulatory expenses are included in their allowable costs as one of inputs. In specifying the model the regulatory expenses will be normalized by the size of firm to measure the relative intensity of firm's expenditure in regulatory process. Otherwise, a large firm's

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<sup>41</sup>Besides Salomon Brothers Inc., several investment research organizations including Value Line Investment Service also rate state regulatory commissions as an aid to prospective utility investors.

effort in the regulatory process will be reflected as greater than a small firm's since regulatory expenses of large firms are usually larger than those of small firms. As proxies for the size of the firm, total megawatt-hour sales and total electric operating revenues will be used. The sign of the regulatory expenditure intensity variable is hypothesized to be positive.

Fifth, the firm will also take into consideration what they are presently earning. Firms may attempt to obtain formal approval of maintaining at least the currently earned rate of return from the commission in the rate case. Protection of the currently earned rate of return leads the firm to request at least higher rate of return than the presently earned rate of return. Hence, the requested rate of return is hypothesized to be positively associated with the rate of return that is currently being earned.

The last variable included in the model is the allowed rate of return in the firm's previous rate case which may provide the firm with an approximate level the commission is considering granting, and thus the firm expects to obtain at least a rate that is close to the last allowed rate of return in the current case. Usually the previously allowed rate of return can be a bottom line the firm can receive from the commission. The sign of the previously allowed rate of return is expected to be positive.

The empirical specification of the firm request equation (with a priori expected signs indicated in parentheses above the coefficients) is given by

$$\begin{aligned}
 RF = & \alpha_0 + \overset{(+)}{\alpha_1} YLD + \overset{(+)}{\alpha_2} DER + \overset{(+)}{\alpha_3} INU + \overset{(?)}{\alpha_4} CLM + \overset{(+)}{\alpha_5} EXPI + \overset{(+)}{\alpha_6} ROE \\
 & + \overset{(+)}{\alpha_7} LRC + u_1
 \end{aligned} \tag{9}$$

where RF = the rate of return on equity requested by the  
regulated firm

YLD = dividend yield

DER = a measure of the firm's risk (debt to equity  
ratio)

INU = the rate of interest (yield on AAA utilities  
bonds)

CLM = regulatory climate (rankings of state regulatory  
commissions)

EXPI = regulatory expenditure intensity  
(= regulatory expenses / total megawatt-hour  
sales or total revenues)

ROE = currently earned rate of return on equity

LRC = the allowed rate of return on equity in the last  
rate case of the firm

$u_1$  = random disturbance term.

## 2) The Staff Recommendation Equation

When regulated utilities file for rate increases, the commission staff reviews and critiques the firm's request. It also prepares and presents its own testimony in rate cases. The staff members generally possess technical skills such as analyzing financial and economic data of the firm and evaluating the proposals of the firm. The commissioners

sometimes lack technical competence for analyzing specific matters on the rate case and may have to rely on the staff whose job includes assistance and advice to the commissioners. The opinions of the commissioners are often shaped by the staff. Reading several case decisions suggests that the commission decision usually approximates the staff recommendation. Particularly the allowed rate of return is generally determined around the rate of return recommended by the staff. Thus the importance of the staff in the decision process of the commission naturally leads to introduction and analysis of the staff recommendation equation.

The rate of return on equity the staff presents before the commission may be based on several factors. A general specification of the staff recommendation equation is given as follows.

Staff's recommended rate of return =  $f$ ( firm's requested rate of return, intervenor's suggested rate of return, previously allowed rate of return, currently earned rate of return, efficiency of the firm, regulatory expenditure intensity.)

The staff is likely to base its suggested rate on the rate of return requested by the firm and suggested by the intervenor.<sup>42</sup> These two figures set boundary figures within which the staff's recommended rate

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<sup>42</sup>A typical intervenor in a rate case is attorney general's consumer protection division (or the office of consumer advocate).

of return is determined.<sup>43</sup> It appears that the rate of return requested by the firm sets the upper bound and the rate of return suggested by the intervenor the lower bound. Thus the rate of return suggested by the staff is expected to vary positively with the rates of return provided by both the firm and the intervenor.

Another variable included in the staff equation is the previously allowed rate of return which the staff may utilize in reaching its recommendation. Since the commission's decision is largely based on the staff's recommendation, the last allowed rate of return (LRC) is a reflection of the staff's recommended rate of return on equity of the firm's previous case. Thus the previous view contained in the LRC may also have an impact on the staff's recommendation. It is expected that the rate of return recommended by the staff is positively associated with the previously allowed rate of return. In addition, the currently earned rate of return (ROE) is included in the staff equation to see how the staff reacts to the firm which is currently earning a high (or low) rate of return. The staff is likely to restrict the firm earning a high rate of return since the staff is also functioning as a protector of public interest. The staff is also likely to increase the allowed rate for a firm currently earning a low rate of return. Thus the expected sign of the ROE should be negative.

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<sup>43</sup>Since the hearing process involves rather a long process of several testimonies (including presentation of evidence and cross-examination), rebuttal testimonies, and filing briefs and reply briefs, through this process the commission staff can accommodate the intervenor's opinion on the rate of return in its recommendation of the allowed rate of return.

Efficiency of regulated firms is one of the concerns with which regulators are dealing. The staff may recommend a high rate of return as a reward for the firm which achieved efficiency in production and management. Thus it is hypothesized that the efficient firm may get a recommendation of a high rate of return from the staff. The expected sign of the efficiency variable is positive. In fact, it is very difficult to find a suitable proxy for measuring efficiency of the firm. As a proxy for a variable measuring the efficiency of the firm, the rate of return on rate base, earned in the previous year of the filing year, is used.

The fifth variable in the equation is the intensity of firm's regulatory spending. The commission staff is also likely to be influenced by the effort of the firm. Once the firm recognizes the importance of the staff in rate cases, the firm's efforts in cooperation with the staff in terms of providing requested service, favors, etc. (and thus the regulatory expenses) will be increased. Hence the firm's increased effort may positively influence the staff's recommended rate of return. However, it is also plausible that the commission staff functions as a defender for the public's interest. The staff may then be relatively free from the regulated firm's influence. It may rather act against the firm's regulatory efforts. Increased regulatory efforts of the firm may turn the staff away from favorable recommendations. Therefore, we should not rule out the possibility that the staff may not recommend a high rate of return for the firm which increased its regulatory expenses excessively. In addition, since the staff is not a real decision maker, the staff may be overlooked by the firm and thus a

major portion of the firm's effort will be devoted to commissioners. This alienation may also lead the staff to recommend a lower rate of return to the firm whose regulatory spending is relatively large. Increased regulatory expenses may help or hurt the firm depending on how the staff perceives the firm's intensified regulatory effort. Thus the expected sign of the coefficient of the regulatory expenditure intensity is indeterminate.

The specification of a model of the staff's recommendation of the rate of return on equity (with hypothesized signs) is given by

$$RS = \beta_0 + \overset{(+)}{\beta_1} RF + \overset{(+)}{\beta_2} RI + \overset{(+)}{\beta_3} LRC + \overset{(-)}{\beta_4} ROE + \overset{(+)}{\beta_5} EFF + \overset{(?)}{\beta_6} EXPI + u_2 \quad (10)$$

where RS = the rate of return recommended by the staff

RI = the rate of return suggested by the intervenor

EFF = the efficiency of the firm (previously earned rate of return on the firm's rate base)

$u_2$  = error term.

### 3) The Commission Decision Equation<sup>44</sup>

After the firm files the rate case, testimony and exhibits by the firm, intervenors, and staff, cross-examination, and rebuttal of the witnesses' testimony ensue. After closing the hearing process, the commission reviews all the records and evidence, and delivers its decision. Factors the state regulatory commissions take into

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<sup>44</sup>The commission here means rather a panel of commissioners as a final decision maker, separated from the staff.

consideration, and their weights may vary from state to state and even from decision to decision. The following factors are hypothesized to affect the decision process of the commission. A general specification of a model of the commission's determination on the allowed rate of return on equity is given by

The allowed rate of return = f (staff's recommended rate of return, firm's requested rate of return, regulatory expenditure intensity, regulatory climate, composition of customers, term of commissioners, number of commissioners).

First, the commission, as an arbitrator or converger of different arguments, weighs the rate of returns requested by the firm (RF), suggested by the intervenors (RI), and recommended by the staff (RS). Among the three rates of return, the RS, which is usually between RF and RI, may be the most reliable variable to the commission. Generally, the rate of return allowed by the commission is determined somewhere between RF and RS but close to RS. Since the allowed rate of return is determined between RF and RS, the two variables will be included in the equation. Although the commission may take a look at the intervenor's rate of return (RI), and also the RI may function as a variable measuring the degree of opposition, it is omitted from the commission equation because the RS already reflects the RI.

Second, like the staff the commission may also be subject to influence from the firm. There exists an incentive for the firm to influence the commission and thereby to obtain a high allowed rate of

return and profits.<sup>45</sup> It may be of interest to examine whether this incentive actually leads the firm to exert an influence on the regulatory outcome -- the allowed rate of return here. It is hypothesized that the allowed rate of return increases as the firm increase its intensity of the regulatory spending. If the empirical result supports this hypothesis, we can conclude that the commission decision is partly shaped by the firm and that the allowed rate of return is not determined exogenously.

Third, the general regulatory environment may influence the determination of the allowed rate of return. The allowed rate of return of the firm operating in favorable regulatory climate jurisdiction may be higher than that in unfavorable regulatory climate jurisdiction. The sign on the regulatory climate variable is anticipated to be negative since a less favorable commission attitude toward the regulated firm (ranking is high) is likely to result in a lower allowed rate of return.

Fourth, the composition of the customers may also affect the outcome of the hearing process. If the customers of the regulated firm are well organized and easily united in protecting their interests, then the degree of opposition the firm faces in the rate case will be larger than otherwise and therefore the firm may not be as likely to get a high rate of return. Large industrial firms can be regarded as well organized and important customers and may become aggressive challengers

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<sup>45</sup>The mathematical proof of the existence of the incentive of the firm to influence the commission's decision is provided in the previous section.

in opposing the utilities' attempt to obtain a favorable rate of return. If the large industrials' consumption constitutes a considerable portion of the sales in the market of the utility, the degree of challenge may be greater and thus the commission may not be able to allow a high rate of return. Thus it is hypothesized that as the ratio of sales to large industrial customers to total sales to ultimate customers increases, the allowed rate of return decreases.

Finally, the characteristics of the commissioners may also influence the allowed rate of return. Two variables are included in the equation. The term of commissioners may have an impact on the allowed rate of return. As the term of commissioners becomes longer, they feel more job security and have less concern regarding their renewal. Since the commissioner's job security can be guaranteed until their term expires, they are less subject to public pressure if their terms are long. However, commissioners with short terms may react more sensitively to the public. In addition, as the term becomes longer, an intimate relationship between the incumbent commissioners and the regulated firm can be more easily developed. The firm may have difficulty in getting a favorable allowed rate of return if commissioners are frequently changed because of short term. It may be easier for the firm to deal with a long-associated commissioner than a new and zealous commissioner. In addition, the return of the firm's accumulated investment on a given commissioner may come slowly and could be seen during the later period of his term. Therefore, where the term is short, the time may not be sufficient for the firm to get any benefit

from the personal investment on the commissioner. Hence the expected sign of the coefficient on the term of commissioners is positive.

The number of commissioners will also have an impact on the allowed rate of return. As the number of commissioners increases, the degree of agreement among commissioners is likely to decrease, and the degree and frequency of scrutinization and questioning of the firm's requested rate of return may be intensified. From the viewpoint of the firm it is easier to persuade the commission with a small number of commissioners than that with a large number of commissioners. As the number of commissioners increases, the firm's effort on persuading commissioners should be increased. Hence getting a high rate of return will be tougher as the number of commissioners increases. Thus the sign of the coefficient of the number of commissioners variable is hypothesized to be negative.

As seen in the above, most variables included in the commission equation are political variables rather than economic ones. The reasons for this can be found in the following two considerations. Since the commission is viewed as a final decision maker rather than an analyst, it may not look at specifics of the rate case; but, rather, it may attempt to gain an overview of the rate case. Regarding technical and specific matters, the commission can depend on the staff.

Secondly, the backgrounds of the commissioners may not be suitable for analyzing economic and financial aspects of rate cases. The previous occupations of most commissioners are lawyer, politician, and

businessman.<sup>46</sup> There are not many regulatory commissioners who are professionally trained in the area of either economics, accounting or engineering.<sup>47</sup> That is, the nature of the decision maker and inadequate knowledge and experience of most commissioners may make it more difficult for them to analyze rate cases independently. Thus the attention of the commissioners may be paid to non-economic or political matters rather than to economic issues such as the calculation of the cost of capital.

The empirical specification of the commission decision equation with hypothesized signs is

$$\begin{aligned}
 RC = & \gamma_0 + \overset{(+)}{\gamma_1}RS + \overset{(+)}{\gamma_2}RF + \overset{(+)}{\gamma_3}EXPI + \overset{(-)}{\gamma_4}CLM + \overset{(-)}{\gamma_5}OPP + \overset{(+)}{\gamma_6}TCM \\
 & + \overset{(-)}{\gamma_7}NCM + u_3
 \end{aligned} \tag{11}$$

where RC = the allowed rate of return by commission

OPP = the composition of customers (degree of  
opposition)

( = sales to large industrial customers / total  
sales to ultimate customers)

TCM = the term of commissioners

NCM = the number of commissioners

$u_3$  = error term.

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<sup>46</sup>Annual Report of NARUC(1982), pp. 822-823.

<sup>47</sup>It is also acknowledged, however, that there are training programs for commissioners that expose them to financial, economic and accounting jargons and methodologies.

#### 4) The Estimation Method: A System of Equations for

##### Determining the Allowed Rate of Return

A simple econometric representation of the previous three equations can be summarized by the following recursive system:

$$RF = \alpha_0 + \alpha_1 YLD + \alpha_2 DER + \alpha_3 INU + \alpha_4 CLM + \alpha_5 EXPI + \alpha_6 ROE + \alpha_7 LRC + u_1 \quad (9)$$

$$RS = \beta_0 + \beta_1 RF + \beta_2 RI + \beta_3 LRC + \beta_4 ROE + \beta_5 EFF + \beta_6 EXPI + u_2 \quad (10)$$

$$RC = \gamma_0 + \gamma_1 RS + \gamma_2 RF + \gamma_3 EXPI + \gamma_4 CLM + \gamma_5 OPP + \gamma_6 TCM + \gamma_7 NCM + u_3 \quad (11)$$

$$E(u_1) = 0, \quad E(u_2) = 0, \quad E(u_3) = 0, \quad \text{and}$$

$$\text{Cov}(u_1, u_2) = \text{Cov}(u_1, u_3) = \text{Cov}(u_2, u_3) = 0.$$

In the recursive system each equation can be estimated separately by using ordinary least squares (OLS). Simple OLS technique is thus used for the estimation of the above recursive system.

#### 4. Data

##### 1) Collection Procedure

The initial step in developing the data base was to select rate cases involving the allowed rate of return. To reflect rather recent trend in state commission regulation, rate cases included in data set are relatively recent ones which were decided in 1980 through 1984. The rate cases were selected from various volumes of the Public Utilities Reports (PUR). There are no other publications which provide all the information regarding the firm's requested rate of return (RF), the staff's recommended rate of return (RS), and the intervenor's suggested

rate of return (RI). This information, however, is still difficult to obtain from every rate case contained in the PUR. In fact, if there were no available data on the variables, such as RS and RI, they were treated as missing observations although it was not always clear whether those were really missing or nonexistent. Due to these missing values the number of observations utilized in estimation of each equation varies.

Among rate cases dealing with the allowed rate of return contained in the PUR, all possible electric companies' cases decided under state regulatory commissions rather than gas companies' cases were included in the data set. The primary reason for eliminating gas companies' rate cases was that data for one of the important variable such as the regulatory expenses for gas companies were not available.

Once the rate cases in the data set were decided, the variables representing the characteristics of the company in the rate cases and the variables regarding the concerned state commission were collected from various sources and added to the data base.

## 2) A Brief Description of the Data Set

The total number of rate cases (observations) contained in the data set is 122. These 122 rate cases can be broken down into 97 electric rate cases, 13 electric and gas rate cases, 6 gas rate cases, 3 electric, gas and water cases, 1 steam case, 1 electric and water case, and 1 electric, gas and steam case. The number of companies in 122 observations is 73. The number of state regulatory commissions involved in at least one rate case is 37. Table 1 provides characteristics of the variables used in this study.

Table 1. Selected characteristics of the data set

| variable | No. of observation | mean        | standard deviation | minimum value | maximum value |
|----------|--------------------|-------------|--------------------|---------------|---------------|
| RF       | 122                | 16.969      | 1.379              | 14.00         | 21.00         |
| RS       | 99                 | 15.113      | 1.156              | 12.71         | 17.92         |
| RI       | 87                 | 14.479      | 1.07               | 12.13         | 17.30         |
| RC       | 121                | 15.332      | 1.022              | 13.00         | 17.86         |
| LRC      | 97                 | 15.032      | 1.152              | 12.42         | 17.75         |
| ROE      | 120                | 12.710      | 2.556              | 6.90          | 20.10         |
| ROB      | 120                | 9.958       | 1.768              | 6.42          | 16.85         |
| LROB     | 121                | 9.241       | 1.629              | 3.94          | 14.91         |
| INC      | 122                | 12.724      | 1.759              | 9.16          | 15.49         |
| INU      | 122                | 13.366      | 2.120              | 9.28          | 17.21         |
| YLD      | 100                | 11.571      | 1.479              | 7.60          | 18.00         |
| DER      | 119                | 1.267       | .236               | .374          | 1.897         |
| CLM      | 122                | 6.467       | 2.017              | 1             | 10            |
| TCM      | 122                | 5.934       | 1.655              | 3             | 10            |
| NCM      | 122                | 3.754       | 1.344              | 1             | 7             |
| EXPI1    | 122                | .1033       | .1484              | .0048         | 1.1226        |
| EXPI2    | 122                | .0019       | .0033              | .0001         | .0296         |
| LEXPI1   | 121                | .0768       | .1006              | .0043         | .8829         |
| LEXPI2   | 121                | .0016       | .0022              | .0001         | .0193         |
| EXP      | 122                | 1,035,572   | 973,439            | 8437          | 4,124,322     |
| EEX      | 122                | 508,741,392 | 560,486,220        | 16,813,887    | 3,302,343,695 |

### 3) Sources

The data used in this study were collected from the following sources.

#### (A) The Public Utilities Reports (PUR)

The PUR cites selected regulatory case decisions of state regulatory commissions as well as state and federal courts.<sup>48</sup> Rate cases involving the rate of return decided between 1980 and 1984 were chosen from reading case decisions in the PUR. From the PUR, the allowed rate of return on common equity (RC), the rate of return requested by the firm (RF), the rate of return recommended by the staff (RS), the rate of return suggested by the intervenors (RI), and the regulatory lag (LAG) were collected. The regulatory lag variable will be used in the next chapter. The RF is the figure requested from either the company's employees or expert witness for the firm. When there are more than one requested rates of return, an average of those requested rates was used. Also the intervenor's suggested rate of return is an average figure if more than one intervenor presented their suggested rates.

#### (B) Financial Statistics of Selected Electric Utilities (formerly Statistics of Privately Owned Electric Utilities) (FSSEU)

The FSSEU lists the financial statistics of about 200 electric utilities whose annual operating revenues are over \$1 million. From the

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<sup>48</sup>Rate cases decided by state and federal courts are not included in the data set.

FSSEU, firm's annual regulatory expenses (EXP), total megawatt-hour sales (SLT), total electric operating revenues (ERV), total electric operation and maintenance expenses (EEX) (used in the next chapter), the (long-term) debt to equity ratio (DER), the ratio of sales to large industrial customers to total sales to ultimate customers (OPP), currently earned rate of return on equity (ROE), the previously earned rate of return on firm's rate base (LROB), and the earned rate of return on firm's rate base (ROB) were obtained. The regulatory expenses defined in the FSSEU mainly include all expenses incurred in formal rate cases and payments made to a regulatory commission for fees assessed against the utility for maintenance of the commission.<sup>49</sup>

(C) The Annual Report on Utility and Carrier Regulation of the

National Association of Regulatory Utility Commissioners (NARUC)

From this publication, the term of commissioners (TCM), the number of commissioners (NCM), and the allowed rate of return (RC) were obtained. The allowed rate of return collected from this publication were used to check whether the rate obtained from the PUR was correct or not. The previously allowed rate of return (LRC) was also obtained from this publication by simply tracing the allowed rate of return of the previous rate case.

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<sup>49</sup>Sometimes a rate case is filed in a given year and decided in the next year. In this case it is difficult to find a relevant year. Thus, the regulatory expenses of the year in the middle point of time between filing and decision of the case is used.

(D) The Salomon Brothers Inc.

The Salomon Brothers Inc. publishes rankings of state regulatory commissions, which were used to represent the regulatory climate variable (CLM). The company classifies the rankings of the commissions into 10 classes (A, A<sup>-</sup>, B<sup>+</sup>, B, B<sup>-</sup>, C<sup>+</sup>, C, C<sup>-</sup>, D, and E). The highest ranking is A and the lowest E. In the data set A was treated as 1 and thus E as 10. That is, the higher number means that the regulatory climate within the commission is less favorable toward the firm. This ranking is based on a number of factors including such items as test period used, accounting method applied, the inclusion of construction work in progress, and the allowed rate of return.

(E) The Public Utilities Fortnightly (PUF)

The PUF publishes the dividend yield of electric utilities in its Stock Summary section every month. The dividend yield used in data set is average annual dividend yield of the filing year of the rate case. From 1983, it has published Annual Survey of Electric Cases which contains the allowed rate of return (RC) and the last allowed rate of return (LRC). Some of the previously allowed rate of returns obtained from this publication were used and checked against the last allowed rate of returns obtained from the Annual Reports of the NARUC.

(F) Federal Reserve Bulletin (FRB)

As the rate of interest, yields on the AAA utility bonds (INU) and yields on the AAA corporate bonds (INC) at the month of filing the rate case were collected from the various issues of FRB.

(G) The Value Line Investment Survey (VLIS)

The value of the beta coefficient as another measure of the riskiness of the firm is obtained from the VLIS.

5. Empirical results

In this section the empirical results obtained from estimating the three-equation recursive system are presented and discussed.

1) The Firm Request Equation

The OLS estimation results for the firm request equation are provided in Table 2. Two different regression results are presented according to different measures of the regulatory expenditure intensity (EXPI). The two alternative measures used are EXPI1 (the regulatory expenditures divided by total megawatt-hour sales) and EXPI2 (the regulatory expenditures divided by total electric operating revenues).<sup>50</sup>

The examination of the regression results shows that the dividend yield (YLD) is statistically significant and reveals the expected sign. This implies that the dividend yield is a major factor in the firm's determination of the requested rate of return on equity. This result is not really surprising since the DCF method is most frequently used in the rate hearing. The effect of the firm's risk on the firm's requested

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<sup>50</sup>The presentation of the results according to the two different measures of the regulatory expenditure intensity (which is a prime variable of interest) is intended to provide a robustness of the significance of the variable. Also, the estimation results of the staff equation and the commission equation will be presented in the same manner.

Table 2. OLS estimation of the firm request equation  
Dependent variable : RF

| independent variable | expected sign | when EXPI=EXPI1 <sup>a</sup> |                   | when EXPI=EXPI2 <sup>b</sup> |                   |
|----------------------|---------------|------------------------------|-------------------|------------------------------|-------------------|
|                      |               | coefficient                  | t-ratio           | coefficient                  | t-ratio           |
| YLD                  | +             | .5553                        | 5.93*             | .5585                        | 5.85*             |
| DER                  | +             | .3101                        | .47               | .2464                        | .37               |
| INU                  | +             | .2101                        | 3.92*             | .2047                        | 3.77*             |
| CLM                  | ?             | -.0557                       | -.85              | -.0486                       | -.73              |
| EXPI                 | +             | 3.2530                       | 2.51*             | 161.44                       | 2.03*             |
| ROE                  | +             | .1474                        | 2.64*             | .1476                        | 2.59*             |
| LRC                  | +             | .1132                        | 1.00              | .1285                        | 1.12              |
| Intercept            |               | 3.901                        | 2.11              | 3.7644                       | 2.00              |
|                      |               | $R^2 = .61$                  | $\bar{R}^2 = .57$ | $R^2 = .60$                  | $\bar{R}^2 = .56$ |
|                      |               | F = 16.61                    | n = 82            | F = 15.87                    | n = 82            |

\* Significant at 5% level, one-tailed test. This 5% level of significance criteria will be used throughout the presentation of the empirical results.

a: EXPI1= firm's regulatory expenditures / total megawatt-hour sales

b: EXPI2= firm's regulatory expenditures / total electric operating revenues

notes: The violation of the homoscedasticity assumption in the OLS estimation of the firm request equation (as well as the staff equation and the commission equation) was checked by both the graphical method and Goldfelt-Quandt method, both of which found no presence of the heteroscedasticity problem.

rate of return is statistically insignificant in spite of the correct sign. Specifically, the coefficient on the debt to equity ratio variable (DER) is insignificant. In addition to the DER, the beta coefficient (BTA) and the debt-to-asset ratio (DET) as other measures of the firm's riskiness were also used. (The results are not presented here). But neither of the coefficients was statistically significant. Hence, the regulated firm does not seem to take its risk into the consideration of the requested rate of return. This insignificance may be due to a lack of sufficient variation in risk among the firms in the sample.

The coefficients on the interest rate on AAA utility bonds (INU) at the month of filing the rate case are statistically significant and have the expected sign. In addition to the INU variable, the interest on AAA corporate bonds (INC) was also used. The coefficient on the INC was also statistically significant and indicated the expected sign (the result is provided in Table A.1 in the appendix). This significant coefficient on the interest rate on AAA utility bonds (INU) (and on AAA corporate bonds (INC)) indicates that the general market level of the cost of financing is another important variable the firm considers. The interest rates on the long-term bonds are usually lower than the rate of return on equity because of lower risk premium on the bonds.

The insignificant coefficient on the regulatory climate variable indicates that the firm's requested rate of return is not dependent on the regulatory environment in which the firm is operating. And, contrary to the previous studies which have found that the cost of capital of the firm operating in an unfavorably regulatory climate is

higher than that of the firm operating in a favorable regulatory climate, the result implies that the regulatory environment does not significantly influence the firm's cost of capital and, consequently, that the regulatory climate does not make a difference in the firm's request on the rate of return on equity. Although it may not be meaningful to interpret the sign of the insignificant regulatory climate variable, the negative sign on the CLM may imply that the regulated firm operating in less favorable regulatory climate does not inflate its requested rate of return. Rather, it realistically reduces its requested rate to an acceptable level to the commission.

The regulatory expenditure intensity (EXPI), the primary variable of interest in the firm request equation, shows that the coefficients on both measures of the firm's regulatory expenditure intensity, EXPI1 and EXPI2, are positive and statistically significant.<sup>51</sup> The interpretation of this result is that an increase in the magnitude of regulatory expenditure relative to the size of the firm leads the regulated firm to request a high rate of return. As the firm increases its regulatory input in the rate case, the expected output will be greater and thus the firm requests higher rate of return than otherwise.

When the firm files for a rate case, the actual process of the filing, in fact, starts well before it files for a formal rate case. As Joskow (1973) indicated, the firm decides whether or not to file a rate

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<sup>51</sup>When the regulatory expenditures are normalized by another proxy for the size of the firm, total electric operation and maintenance expenses, the regulatory expenditure intensity variable is still significant.

increase request. This decision process may include the analysis of the firm's financial conditions, of costs and benefits resulting from the filing, and of the probability of obtaining an approval of the rate increase request. Due to these pre-filing procedures, the firm incurs regulatory expenses even far before it files its rate case. Also, once the firm decides to file for a rate case, it may start increasing the regulatory expenditures in an attempt to influence a regulatory outcome even before it files the case. As a result, this regulatory expenditures may also be reflected in the regulatory expenses of the previous year of the filing.

Therefore, another attempt was made to present further evidence on the significance of the EXPI by replacing the EXPI with the LEXPI which is the regulatory expenditures of the previous year of the filing year of the rate case divided by the total megawatt-hour sales (or total electric operating revenues) of the previous year of the filing. The result is reported in Table 3. The coefficients on both LEXPI1 and LEXPI2 are statistically significant. In fact, the t-ratios of the LEXPI are even higher than those of the EXPI in Table 2.<sup>52</sup> Thus, the results clearly support the hypothesis that the firm's requested rate of return is positively related to the regulatory expenditure intensity.

Another interesting result is that the coefficient on the currently earned rate of return (ROE) is statistically significant and shows the

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<sup>52</sup>The results, when the interest rate on AAA corporate bonds (INC) instead of the INU is used, are also provided in Table A.2 in the appendix.

Table 3. OLS estimation of the firm request equation  
Dependent variable: RF

| independent variable | expected sign | when $LEXPI=LEXPI1^a$ |                   | when $LEXPI=LEXPI2^b$ |                   |
|----------------------|---------------|-----------------------|-------------------|-----------------------|-------------------|
|                      |               | coefficient           | t-ratio           | coefficient           | t-ratio           |
| YLD                  | +             | .5648                 | 6.10*             | .5647                 | 5.99*             |
| DER                  | +             | .3504                 | .54               | .2518                 | 0.38              |
| INU                  | +             | .2067                 | 3.92*             | .1996                 | 3.73*             |
| CLM                  | ?             | -.0640                | -.99              | -.0470                | -.72              |
| LEXPI                | +             | 4.2536                | 2.96*             | 161.47                | 2.46*             |
| ROE                  | +             | .1615                 | 2.97*             | .1630                 | 2.95*             |
| LRC                  | +             | .0864                 | .78               | .1133                 | 1.00              |
| Intercept            |               | 4.0392                | 2.22              | 3.7857                | 2.05              |
|                      |               | $R^2 = .62$           | $\bar{R}^2 = .59$ | $R^2 = .61$           | $\bar{R}^2 = .57$ |
|                      |               | $F = 17.43$           | $n = 82$          | $F = 16.53$           | $n = 82$          |

notes:

a:  $LEXPI1$  = regulatory expenses of the year before the filing year / total megawatt-hour sales of the year before the filing year

b:  $LEXPI2$  = regulatory expenses of the year before the filing year / total electric operating revenues of the year before the filing year

expected positive sign. On the other hand, the last allowed rate of return (LRC) is not significant although it shows the expected sign. This may imply that the firm puts emphasis on the currently earned rate of return rather than on the previously allowed rate of return. From the viewpoint of the firm, the level of return it was given in the previous case may not be relevant in determining what rate it should be earning in the future in order to maintain and attract necessary capital. It may not be unusual for the firm to request its rate of return at least above the currently earned rate of return. It is seen from the characteristics of the sample that an average of the earned rate of return on equity is 12.71, but an average of the firm's requested rate of return is 16.97. It seems that the currently earned rate of return is an important variable the firm considers.

In summary, the significant variables in the firm request equation are the dividend yield, the rate of interest on both AAA utility and AAA corporate bonds, the currently earned rate of return, and the regulatory expenditure intensity. The insignificant variables are the firm's risk, the regulatory climate, and the previously allowed rate of return.

## 2) The Staff Recommendation Equation

The OLS estimation results of the staff recommendation equation are presented in Table 4. The estimation results support the hypothesis that the staff's recommended rate of return on equity is mainly based on the rate of return requested by the firm (RF) and suggested by the intervenor (RI), the coefficients of which are statistically significant and have the expected positive signs. These results also suggest the role of the commission staff, in which the staff not only represents the

Table 4. OLS estimation of the staff recommendation equation  
Dependent variable: RS

| independent<br>variable | expected<br>sign | <u>when EXPI=EXPI1</u> |                    | <u>when EXPI=EXPI2</u> |                   |
|-------------------------|------------------|------------------------|--------------------|------------------------|-------------------|
|                         |                  | coefficient            | t-ratio            | coefficient            | t-ratio           |
| RF                      | +                | .3908                  | 4.53 <sup>*</sup>  | .3826                  | 4.37 <sup>*</sup> |
| RI                      | +                | .3622                  | 3.16 <sup>*</sup>  | .3621                  | 3.10 <sup>*</sup> |
| LRC                     | +                | .1824                  | 1.79 <sup>*</sup>  | .1780                  | 1.72 <sup>*</sup> |
| ROE                     | -                | -.0099                 | -.24               | -.0130                 | -.31              |
| EFF                     | +                | .0652                  | 1.11               | .0592                  | 1.00              |
| EXPI                    | ?                | -2.4006                | -1.84 <sup>*</sup> | -132.19                | -1.49             |
| Intercept               |                  | .2680                  | .17                | .5588                  | .36               |
|                         |                  | $R^2 = .68$            | $\bar{R}^2 = .65$  | $R^2 = .68$            | $\bar{R}^2 = .64$ |
|                         |                  | F = 18.09              | n = 57             | F = 17.52              | n = 57            |

public (or intervenors) but also listens to the firm. The estimated elasticities of the staff recommended rate of return with respect to the firm's requested rate of return and the intervenor's suggested rate of return, calculated at the mean values, are 0.44 and 0.35 respectively. This indicates that the staff is slightly more responsive to the firm's request than the intervenor's.

One noticeable result in the staff equation is that the last allowed rate of return (LRC) is significant but the currently earned rate of return (ROE) is insignificant. This is a good contrast. In the firm request equation, the result is the opposite: The ROE is significant but not the LRC. The staff seems to give little consideration to the ROE in its recommendation. The negative sign of the coefficient on the ROE, if not that meaningful, suggests that the staff, in fact, reduces its recommended rate of return if the firm is considered to earn a high rate of return.

The coefficient on the efficiency variable, the earned rate of return on rate base is insignificant.<sup>53</sup> The sign, however, is as expected. Joskow's finding (1972) also indicated that the coefficient for the firm's efficiency variable was insignificant but showed the correct sign. The positive sign, if not meaningful, suggests that the

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<sup>53</sup> As a proxy for the efficiency of the firm, total factor productivity and labor productivity were also used, but neither variable was significant. In fact, it is difficult to find empirical evidence that the regulatory commission is also conscious of the efficiency of the regulated firm since a variable representing the firm's efficiency is not easily found.

staff is likely to recommend a high rate of return if the regulated firm manifests overall efficiency.

The examination of the coefficient on the regulatory expenditure intensity (EXPI1) provides another intriguing result, even if the insignificance of the coefficient on the EXPI2 prohibits a conclusive interpretation. The staff seems to respond negatively to the regulated firm's attempt to influence the regulatory process. This indicates that the staff may be at least neutral or adverse toward the firm's regulatory influencing efforts in its recommendation process. It is encouraging from the perspective of consumers that the staff properly functions its role as an advocate and a representative of the public. This result may not be surprising since the staff is not the real decision maker, and therefore the firm is likely to direct its attention to the commissioners not to the staff. This may make the staff turn hostile toward the firm whose regulatory expenditure intensity is high.

In summary, the significant variables in the staff equation are the rate of return requested by the firm and suggested by the intervenor, the previously allowed rate of return, and the regulatory expenditure intensity (if rather ambiguous). However, a caveat is in order. The t-ratio of the EXPI1 is not really high enough to make conclusively strong interpretation.<sup>54</sup> The insignificant variables are the currently earned rate of return and the efficiency of the firm.

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<sup>54</sup>The EXPI, when normalized by another proxy for the size of the firm (total electric operation and maintenance expenses), is also insignificant.

### 3) The Commission Decision Equation

The result of OLS estimation is reported in Table 5. All the coefficients except the coefficient of the composition of customers (OPP) are statistically significant and show the anticipated signs.

The study of the regression results indicates that the commission's decision is significantly influenced by the staff's recommendation as well as the firm's request. This shows that the commission listens to the parties involved in a rate case although the most significant factor is the rate of return recommended by the staff. When evaluated at the mean values, the estimated elasticities of the allowed rate of return with respect to the staff's recommended rate of return and the firm's requested rate of return are .50 and .24 respectively. This implies that state commissions are more responsive (almost exactly twice as responsive) to the staff's recommendation than to the firm's request. As suggested by the model it seems that the commission does not really have to examine technical aspects of the rate case such as calculation of a cost of capital. It seems that the regulatory commission simply weighs and balances the arguments from the concerned parties. Although the intervenor's rate is not explicitly included in the model, the staff's recommended rate of return implicitly represents the argument of the intervenors. Thus the allowed rate of return appears to be a reflection of opinions of several opposing parties. This result

Table 5. OLS estimation of the commission decision equation  
Dependent variable: RC

| independent<br>variable | expected<br>sign | <u>when EXPI=EXPI1</u> |                   | <u>when EXPI=EXPI2</u> |                   |
|-------------------------|------------------|------------------------|-------------------|------------------------|-------------------|
|                         |                  | coefficient            | t-ratio           | coefficient            | t-ratio           |
| RS                      | +                | .5072                  | 6.77*             | .5033                  | 6.71*             |
| RF                      | +                | .2133                  | 3.72*             | .2185                  | 3.80*             |
| EXPI                    | +                | .8298                  | 2.19*             | 35.37                  | 2.06*             |
| CLM                     | -                | -.0856                 | -2.73*            | -.0829                 | -2.64*            |
| OPP                     | -                | .1710                  | 1.12              | .1664                  | 1.09              |
| TCM                     | +                | .0705                  | 1.78*             | .0701                  | 1.76*             |
| NCM                     | -                | -.0897                 | -1.90*            | -.0912                 | -1.92*            |
| Intercept               |                  | 4.3956                 | 4.72              | 4.3775                 | 4.68              |
|                         |                  | $R^2 = .71$            | $\bar{R}^2 = .68$ | $R^2 = .70$            | $\bar{R}^2 = .68$ |
|                         |                  | F = 31.3               | n = 99            | F = 31.0               | n = 99            |

supports Peltzman's view that regulators take account of opinions of various interest groups, not the opinion of a single interest group.<sup>55</sup>

The result also supports the hypothesis that the regulatory climate affects the allowed rate of return. The negative sign indicates that the firm's allowed rate of return will be lower if it is operating in an unfavorable regulatory climate. Because of this fact, it may be likely for the firm subject to an unfavorable climate jurisdiction to intensify its effort in the regulatory hearing process, for example, by increasing regulatory expenses.

The findings show that the characteristics of the commission also influence the allowed rate of return.<sup>56</sup> The term of commissioners affects positively the allowed rate of return, which can be interpreted as less pressure from the public and greater job security through longer term may positively affect the commission's determination of the allowed rate of return. This finding supports the previous study by Hagerman and Ratchford (1978).

Next, another characteristic of the commission, the number of the commissioners, is also found to be significant and negative as hypothesized. Hagerman and Ratchford (1978), however, hypothesized that

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<sup>55</sup>Peltzman (1976).

<sup>56</sup>It may also be interesting to test whether the commissioners are appointed or elected affects the allowed rate of return. Unfortunately, the inclusion of this dummy variable became useless since most of the observations in the data set were associated with commissions where commissioners were appointed and thus observations associated with elected commissioners were not sufficient. The same is true for the valuation method of the rate base.

the sign of the coefficient on the number of commissioners should be positive according to their "diffusion of responsibility hypothesis." But their regression result showed that the sign, if not significant, is negative. Thus, the negative sign in the present study supports their empirical result and provides additional evidence for rejecting their "diffusion of responsibility hypothesis."

The only insignificant variable with wrong expected sign in the commission decision equation is the composition of customer (OPP). Large industrial customers do not seem to affect the commission's determination process of the allowed rate of return. One possible interpretation of the insignificance of this variable is that the large industrials may not want to create reliability of supply problems by opposing the firm's rate case. Friendly long-term relationships with the utility may be more important for the large industrial companies in order to secure constant power supply.

Finally, turning to the variable of primary interest here, the regulatory expenditure intensity, the regression supports the hypothesis that outcomes of commission regulation can be influenced by the regulated firm. The finding here is that an increase in the firm's regulatory expenses relative to the size of the firm exerts a positive impact on the commission's allowed rate of return.<sup>57</sup> The coefficients on both variables, EXPI1 and EXPI2, are statistically significant. This

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<sup>57</sup>The coefficient of the regulatory expenditure intensity variable, when normalized by another proxy for the size of the firm, total electric operation and maintenance expenses, is still significant.

suggests that the decision of the commission is at least partially shaped by the regulated firm's effort on the preparation and presentation of the rate case. Also the firm's spending on the regulatory hearing process may be profitable. The other implication also follows. As long as the decision process of the allowed rate of return can be influenced (if not totally controlled) by the firm, then the allowed rate of return cannot be considered to be exogenously determined by the commission itself. Therefore, this regression strongly supports the view that the allowed rate of return is not exogenous to the firm.

Regarding the impact of the regulatory expenditure intensity (EXPI) on the allowed rate of return (RC), it is noted that the coefficient of EXPI represents only direct effect on the commission but does not include indirect effects through the RF and RS. In fact, the full impact of EXPI on RC is:

$$\frac{dRC}{dEXPI} = \frac{\partial RC}{\partial RS} \frac{dRS}{dEXPI} + \frac{\partial RC}{\partial RF} \frac{dRF}{dEXPI} + \frac{\partial RC}{\partial EXPI}$$

The former two terms on the right-hand side of the above equation indicate the indirect effects of EXPI on RC and the last term represents the direct effect. The calculated value of the full impact (of EXPI on RC) is .3061, which is less than the direct effect, .8298, since the negative value of  $\partial RS / \partial EXPI$  mostly canceled the positive impact of EXPI on RC.

## 6. Conclusions

In this chapter a simple model of the determination of the allowed rate of return is developed in order to examine the variables

determining the allowed rate of return. From this model we could also explore how the arguments of conflicting parties are reflected in the decision process of the commission and, more importantly, whether the regulatory commission can be influenced by the regulated firm. The OLS estimation of the three-equation recursive system provided relatively satisfactory and meaningful results. Although there are some restrictions on this study such as insufficient and missing observations, we can cautiously derive some implications from the estimation results.

The evidence presented supports the main hypothesis that the regulator is subject to the regulated firm's exercise of influence over the decision making process. Specifically, the regulated firm's effort through adjusting the level of the regulatory expenses can effectively affect the regulatory outcomes -- the allowed rate of return here. In addition the endogeneity of the allowed rate of return is demonstrated by simple regression of the allowed rate of return on the regulatory expenditure intensity.

Some other implications may also be worthwhile to mention. First, the results of the recursive model show that the determination of the firm's allowed rate of return cannot be reduced to a fixed formula but it involves many factors including political aspects. Second, as seen in the commission equation, the commission's decision is largely based on arguments of interested parties in the rate case. Thus the regulatory outcome may be changed according to each party's efforts in the presentation of its case. Third, the staff may not be susceptible to the firm's effort. Rather it could negatively respond to the firm's

regulatory expenditures. Fourth, while the firm's request utilizes its present financial conditions such as the currently earned rate of return (ROE), the staff relies more on the previously allowed rate of return (LRC). This may indicate that each party gives more weight to its own available information. Fifth, the commission's own characteristics such as the term and the number of commissioners can have some impact on the regulatory decision making process. Sixth, the firm's spending on the preparation and presentation of the rate case (e.g., by hiring expert witnesses) may be profitable.

## CHAPTER V

### ENDOGENOUS REGULATION AND THE FIRM'S REGULATORY EXPENSES

#### 1. Introduction

The previous chapter examined how the regulatory expenditure intensity affects the determination process of the allowed rate of return. The findings indicate that the regulated firm has some control over its allowed rate of return. Given this control, regulation becomes endogenous to the firm's decision making process. Such endogeneity, in turn, can be expected to manifest itself in certain aspects of the regulated firm's behavior. Behavioral implications of the endogeneity of regulation, however, have not been explored to any significant degree in the extant literature. An investigation of such implications, both theoretically and empirically, would serve to extend and strengthen the economic theory of regulation.

This chapter investigates one such behavioral aspect of endogenous regulation. Specifically, it examines the determinants of the firm's regulatory expenses -- the expenditures that the firm incurs in its attempt to influence regulatory outcomes. If regulation is, indeed, endogenous, these expenses should respond to economic factors affecting the marginal costs and the marginal revenues of influencing commission decisions on matters such as setting the allowed rate of return. The purpose here is to explore the role that these factors play in affecting this particular aspect of regulated firm behavior.

This chapter is organized as follows. Section 2 develops a simple model to derive the firm's optimal level of regulatory expenditures

under the assumption that these expenditures affect the allowed rate of return granted by the regulatory commission and the commission's valuation of the firm's rate base. It then derives several hypotheses concerning the determinants of these optimal expenditures. Section 3 specifies an empirical model that is then used to test these hypotheses. The empirical results are presented in section 4. Section 5 then concludes the chapter.

## 2. The Firm's Optimal Regulatory Expenditures

If the firm is able to influence regulatory decisions by adjusting the level of its regulatory expenses (e.g., by hiring expert witnesses or conducting cost of capital studies), then the regulated firm will tend to seek an optimal expenditure on rate hearings. This section first presents a simple model that can be used to derive this optimum and then investigates the hypotheses implied by this model.

Throughout the analysis, it is assumed that the regulated firm is able to influence two basic regulatory decisions through its expenditures ( $E$ ) on the hearing process. First, it is able to affect the allowed rate of return ( $S$ ) that is approved by the regulatory commission (i.e.,  $S = S(E)$ ). Here, it is assumed that a higher rate of return will be granted if regulatory expenditures are increased (i.e.,  $S_E > 0$ ). That is, by presenting cost-of-capital testimony and other evidence to support its request, the firm is able to increase the allowed rate of return that is granted. It is also assumed, however, that the second derivative of  $S(E)$  is negative i.e., that the marginal effect of increasing regulatory expenditures on the allowed rate of

return declines as these expenditures increase. Thus, it is assumed that  $S_{EE} < 0$ . This assumption is motivated by an expectation that there is some maximum allowed rate of return that the regulatory commission will not exceed regardless of the firm's expenditures on the hearing process.

Second, it is assumed that the firm is able to influence the commission's determination of the value of its rate base,  $B$  (for a given quantity of invested capital,  $K$ ) through its expenditures on the hearing process (i.e.,  $B = B(E, K)$ ). By providing additional testimony and evidence, the firm may be able to include items in its rate base that would otherwise be excluded, or it may be able to increase the commission's valuation of included items. In either event, its rate base will be expanded. Thus, it is assumed that  $B_E > 0$ . Here, too, it is assumed that the second derivative of the rate base with respect to regulatory expenditures is negative (i.e.,  $B_{EE} < 0$ ). Next, it is assumed that an increase in the firm's capital stock increases the rate at which the approved rate base expands in response to an increase in the firm's regulatory expenditures (i.e.,  $B_{EK} > 0$ ). This simply means that the opportunities for the firm to increase its rate base through its regulatory expenditures are greater for larger firms. Finally it is assumed that an increase in the firm's capital stock increases the rate base (i.e.,  $B_K > 0$ ).<sup>58</sup>

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<sup>58</sup>No assumption concerning the sign of the second partial derivative of the firm's rate base with respect to the capital stock is required for this analysis.

The definitions and assumptions can thus be summarized:

$E$  = expenditures of the regulated firm on the hearing process

$S = S(E)$  = the allowed rate of return determined at the rate hearing, where  $S_E > 0$  and  $S_{EE} < 0$

$K$  = the size of the firm's capital stock

$B = B(E, K)$  = the approved valuation of the firm's rate base, where  $B_E > 0$ ,  $B_{EE} < 0$ ,  $B_K > 0$ , and  $B_{EK} > 0$

$T$  = length of time to completion of the next rate hearing (regulatory lag)

$r$  = the firm's discount rate.

Given these definitions, the discounted present value of net operating profits arising from current regulatory expenditures is

$$\pi = \int_0^T e^{-rt} [S(E)B(E,K)] dt - E. \quad (1)$$

In other words, net profits are simply the allowed rate of return times the rate base discounted over the relevant period minus the firm's expenditures on the hearing process. The former term represents the (discounted) total net revenue generated by the firm's influence over the hearing process, and the latter represents the total costs of exercising this influence at the time of the hearing. The firm's problem, then, is to choose a level of expenditures,  $E$ , to devote to the hearing that will maximize (1) for given values of  $K$ ,  $r$ , and  $T$ . Thus, the firm's control variable is  $E$ ; and  $K$ ,  $r$ , and  $T$  are parameters.

Since both  $S$  and  $B$  are set at the hearing and remain constant until the conclusion of the next hearing at time  $T$ , (1) may be rewritten as

$$\pi(E; K, r, T) = S(E)B(E, K) \frac{1}{r} (1 - e^{-rT}) - E \quad (2)$$

Maximizing (2) with respect to  $E$  yields the first-order condition,

$$\pi_E = (S_E B + B_E S) \frac{1}{r} (1 - e^{-rT}) - 1 = 0 \quad (3)$$

The second-order condition requires that

$$\pi_{EE} = (S_{EE} B + 2B_E S_E + B_{EE} S) \frac{1}{r} (1 - e^{-rT}) < 0 \quad (4)$$

By the implicit function theorem, equation (3) implies an explicit function,  $E^* = f(r, T, K)$ , that satisfies

$$F(E^*, r, T, K) = [S_E(E^*)B(E^*, K) + B_E(E^*, K)S(E^*)] \frac{1}{r} (1 - e^{-rT}) - 1 = 0 \quad (5)$$

From equation (5), it is possible to sign the following partial derivatives:

$$F_{E^*} = (S_{EE} B + 2B_E S_E + B_{EE} S) \frac{1}{r} (1 - e^{-rT}) < 0 \quad (6)$$

$$F_K = (S_E B_K + B_{EK} S) \frac{1}{r} (1 - e^{-rT}) > 0 \quad (7)$$

$$F_T = (S_E B + B_E S) e^{-rT} > 0 \quad (8)$$

The inequality given in (6) is required by the second-order condition in (4), and the inequalities in (7) and (8) are implied by the assumptions regarding the  $S(E)$  and  $B(E, K)$  functions.<sup>59</sup>

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<sup>59</sup>In addition, it is found that

$$F_r = - \frac{1}{r^2} (S_E B + B_E S) (1 - e^{-rT}) + \frac{T}{r} (S_E B + B_E S) e^{-rT},$$

which can be shown to be negative.

Given these results, the implicit function rule yields

$$E_K^* = - \frac{F_K}{F_{E^*}} > 0 \quad (9)$$

and

$$E_T^* = - \frac{F_T}{F_{E^*}} > 0 \quad (10)$$

That is, an increase in the firm's capital stock should lead to an increase in its optimal regulatory expenditures. Likewise, an increase in regulatory lag should also cause an increase in these expenditures.<sup>60</sup>

In addition to these two rather unambiguous hypotheses, equation (5) also suggests that the firm's regulatory expenses will be influenced by the regulatory climate within which the firm operates. That is, the shapes of the regulators' response functions,  $S(E)$ , and  $B(E, K)$  affect the optimal level of regulatory expenditures through the derivatives  $B_E$  and  $S_E$  which appear in (5). In effect, these functions determine how difficult it is for the firm to influence regulatory decisions. In the following section, two additional variables are introduced, one that is likely to reflect the regulatory climate faced by the firm, and the other that represents the firm's profitability.

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<sup>60</sup> Given the result in the previous footnote ( $F_r < 0$ ), we also have

$$E_r^* = - \frac{F_r}{F_{E^*}} > 0,$$

i.e., an increase in the firm's discount rate will lead to an increase in optimal regulatory expenditures. This result is intuitively appealing but is not amenable to empirical verification with the current data.

### 3. An Empirical Model of Regulatory Expenses

The preceding analysis indicates that the regulated firm's expenditures on the hearing process will be functionally related to the firm's capital stock, and the length of regulatory lag, and the overall receptiveness of the commission to arguments and evidence that the allowed rate of return should be increased. Here, an empirical model of this functional relationship is specified in order to test the hypotheses derived above along with two additional hypotheses concerning the impact of the regulatory climate and the firm's profitability on the firm's regulatory expenses.

As described in the previous chapter, the data pertain to 120 rate cases of 71 class A and B private electric utilities and the various state commissions that regulate them.<sup>61</sup> The dependent variable, EXP, is the expenditure that the firm incurred in responding to and attempting to influence the outcome of the regulatory process in the given year. It is arguably the principal behavioral manifestation of the endogeneity of regulation in this industry.

Variables entering the right hand side of the equation are the following. First, it incorporates the firm's total electric operation and maintenance expenses, EEX, as a measure of the size of the firm's capital stock. This measure is preferable to total assets or the reported rate bases of the firms in the sample because it avoids the

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<sup>61</sup>These data are the same as the ones used in the previous chapter, except that 2 inappropriate rate cases are dropped from the data set.

myriad problems created by differing valuation and depreciation policies across the firms and regulatory commissions.<sup>62</sup> This variable is incorporated in both linear and quadratic form with the expectation that the coefficient on the linear term will be positive and the coefficient on the quadratic term negative. That is, it is expected that increases in the firm's capital stock lead to increases in regulatory expenses [equation (9)], but the latter is expected to increase at a decreasing rate. This expectation is motivated by the assumption that there is some maximum allowed rate of return that the commission will not exceed regardless of the magnitude of the firm's regulatory expenses.

Next, a measure of regulatory lag, LAG, is introduced. This variable is the length of time (in days) that elapsed between the filing of each rate case in the sample and delivery of a decision for the given commission. An increase in LAG indicates that whatever allowed rate of return is awarded will likely be in effect over a greater period of time due to the reduced speed with which the given commission renders decisions. From equation (10), then, it is expected the coefficient attached to LAG to be positive.

Finally, two variables are incorporated into the model. The first is associated with the receptiveness of the regulatory commission to arguments that the allowed rate of return and/or the rate base valuation should be set relatively high. The regulatory climate variable, CLM, is

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<sup>62</sup>There is considerable variation from jurisdiction to jurisdiction in items included in the rate base (e.g., construction work in progress) and in the valuation and depreciation methods employed.

used to represent the receptiveness of the regulatory commission. The CLM is a ranking of the regulatory climates in the various states. This ranking increases as the regulatory climate becomes relatively less favorable, so high values of CLM indicate increasingly hostile regulatory environments.

Equation (5) does not provide any unambiguous hypothesis about the qualitative impact of CLM on the firm's regulatory expenses. Since this variable influences the entire shape and location of the  $S(E)$  and  $B(E, K)$  functions, increases in CLM may either increase or decrease  $E^*$ . This theoretical indeterminacy is consistent with a priori reasoning. On the one hand, a more hostile regulatory climate may reduce the marginal revenue product of regulatory expenditures and, thereby, encourage the firm to spend less on the hearing process. This would imply a negative sign for the coefficient of CLM. On the other hand, however, a more hostile climate may require the firm to spend more to protect its earnings position. This would imply a positive sign for this coefficient. Consequently, it is difficult to hypothesize an expected sign for the CLM coefficient.

The second variable is the firm's profitability, the firm's earned rate of return on its rate base, ROB. The anticipated sign of the coefficient of ROB is positive because of the following two considerations. First, the firm earning a high rate of return is likely to have more funds available to devote to the regulatory process. And second, the firm whose profitability is high may have an additional incentive to protect its earnings by spending more on hearings.

Together, these arguments suggest that the ROB coefficient will be likely to attain a positive sign.

The empirical specification of the regulatory expense equation (with hypothesized signs indicated in parentheses above the coefficients) is

$$EXP = \omega_0 + \overset{(+)}{\omega_1} EEX + \overset{(-)}{\omega_2} EEX^2 + \overset{(+)}{\omega_3} LAG + \overset{(?)}{\omega_4} CLM + \overset{(+)}{\omega_5} ROB + \varepsilon \quad (11)$$

where EXP = firm's annual regulatory expenses

EEX = total electric operation and maintenance expenses

LAG = regulatory lag

CLM = regulatory climate

ROB = earned rate of return on the firm's rate base

$\varepsilon$  = the random disturbance term.

#### 4. Estimation Results

Estimation results of equation (11) using OLS are shown in Table 6.<sup>63</sup> The findings indicate that increases in the firm's capital stock (as measured by EEX) increase expenditures on the hearing process at a decreasing rate. The coefficients on both the linear and the quadratic terms are statistically significant and show the expected sign. Moreover, calculating the estimated partial derivative of the firm's regulatory expenditures with respect to EEX at the mean value of EEX, it

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<sup>63</sup> The investigation of the presence of heteroscedasticity by plotting the residuals from this equation against the variable EEX showed no violation of the assumption of homoscedasticity.

Table 6. OLS estimation of the regulatory expenses equation  
Dependent variable: EXP

| independent<br>variable | expected<br>signs | coefficient             | t-ratio            |
|-------------------------|-------------------|-------------------------|--------------------|
| EEX                     | +                 | .0025                   | 8.07 <sup>*</sup>  |
| EEX <sup>2</sup>        | -                 | -6.3411E <sup>-13</sup> | -5.33 <sup>*</sup> |
| LAG                     | +                 | 1,637.79                | 1.79 <sup>*</sup>  |
| CLM                     | ?                 | 52,942.69               | 1.57               |
| ROB                     | +                 | 106,823.47              | 2.84 <sup>*</sup>  |
| Intercept               |                   | -1,722,008.7            | -3.24              |
|                         |                   | $R^2 = .50$             | $\bar{R}^2 = .48$  |
|                         |                   | $F = 22.68$             | $n = 120$          |

is found that  $E_{\text{EEX}}^* > 0$  holds. Thus, the hypothesis indicated in expression (9) is supported by these results.

Next, the results show that increases in the length of regulatory lag cause regulatory expenditures to increase, as was hypothesized. This effect is statistically significant. Further empirical support for the model is provided by the evidence concerning the effect of regulatory commission attitudes on the firm's regulatory expenses. Here, the findings show that firms facing a commission with relatively stringent policies (a high value of CLM) will spend more attempting to obtain favorable outcomes. But this effect is significant at the .10 level. Finally a high profitability of the firm (revealed in ROB) encourages greater regulatory expenditures as well. The coefficient on ROB is statistically significant.

Taken together, these results support the view that regulation is endogenous and that the firm's behavior reflects this endogeneity. Thus, they provide empirical support for the overall view suggested by the economic theory of regulation that the regulated firm is aware of the influence that it wields in regulatory decisions. Moreover, these results also indicate that the firm's investment in influencing regulatory outcomes is responsive to those factors suggested by the simple theory of optimal regulatory expenditures that is derived above.

## 5. Conclusions

This chapter derived the optimal level of the firm's regulatory expenses and examined the determinants of these optimum expenses. The evidence presented here provides additional support for the view that

the regulated firm has some degree of control over the earnings "constraint" imposed by the regulatory commission. Some behavioral implications of this endogeneity of regulation have been derived and tested here and have received empirical support. Specifically, the results showed that increases in the firm's capital stock (rate base) and increases in regulatory lag tend to increase its expenditures on the hearing process. In addition, the findings indicated that the variable representing the regulatory commission's receptiveness to evidence presented at the hearing and the variable representing the firm's profitability influence the firm's regulatory expenditures as well. These findings tend to confirm the approach embodied in the economic theory of regulation.

## CHAPTER VI

### CONCLUSIONS

This study has attempted to develop a simple model of the determination of the allowed rate of return in a regulatory proceeding, in which the regulated firm is able to exercise some control over the decision rendered by the the state commission. The implications of this model have been derived and tested. In particular, this study has examined how the firm's regulatory expenses influence the decision process of the parties involved in the determination of the allowed rate of return. The study has also developed a simple model of the firm's optimal regulatory expenditures and has examined the determinants of these optimal expenses.

The major empirical finding, shown in the determination process of the allowed rate of return, is that the regulated firm has some degree of control over the rate of return set by the regulatory commission. So long as the profit rate of the regulated firm is effectively regulated below the monopoly rate, the profit maximizing behavior of the regulated firm will result in the regulated firm's propensity to exercise some control over the regulator. Specifically, an increase in the firm's regulatory expenditures relative to its size can positively affect the commission's decision on the allowed rate of return on equity.

This result then implies the endogeneity of the allowed rate of return, an aspect which has been largely ignored in the prior literature on regulation. This result further suggests that models intended to

capture the regulated firm's behavior should begin to incorporate the possibility of its strategic control over the regulator.

In addition, the result shows that the commission's decision reflects arguments of various interested parties involved in the rate case. This also suggests that the regulatory outcomes can be changed, depending upon the intensity of each party's regulatory efforts. Consequently, these findings tend to provide an additional support for the approach embodied in the economic theory of regulation.

This study has provided some insights into the behavioral implications of the regulated firm that is subject to state regulatory commissions. The present study represents a beginning for the exploration of the endogeneity of regulation. Thus, further studies exploring endogenous regulation and its implications appear to be open to investigation. For example, the Averch-Johnson overcapitalization hypothesis can be reexamined after incorporating the endogeneity of the allowed rate of return into the regulatory constraint.

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## **APPENDIX**

Table A.1. OLS estimation of the firm request equation  
Dependent variable : RF

| independent<br>variable | expected<br>sign | when EXPI=EXPI1 |                   | when EXPI=EXPI2 |                   |
|-------------------------|------------------|-----------------|-------------------|-----------------|-------------------|
|                         |                  | coefficient     | t-ratio           | coefficient     | t-ratio           |
| YLD                     | +                | .5752           | 6.23*             | .5788           | 6.15*             |
| DER                     | +                | .3980           | .60               | .3259           | .48               |
| INC                     | +                | .2634           | 3.94*             | .2562           | 3.79*             |
| CLM                     | ?                | -.0712          | -1.09             | -.0638          | -.97              |
| EXPI                    | +                | 3.4366          | 2.65*             | 173.74          | 2.18*             |
| ROE                     | +                | .1483           | 2.66*             | .1481           | 2.60*             |
| LRC                     | +                | .0597           | .53               | .0777           | .68               |
| Intercept               |                  | 3.8815          | 2.11              | 3.7315          | 1.99              |
|                         |                  | $R^2 = .61$     | $\bar{R}^2 = .58$ | $R^2 = .60$     | $\bar{R}^2 = .56$ |
|                         |                  | $F = 16.67$     | $n = 82$          | $F = 15.91$     | $n = 82$          |

\* Significant at 5% level, two-tailed test.

notes: INC=the rate of interest on AAA corporate bonds

Table A.2. OLS estimation of the firm request equation  
Dependent variable: RF

| independent<br>variable | expected<br>sign | when LEXPI=LEXPI1 |                   | when LEXPI=LEXPI2 |                   |
|-------------------------|------------------|-------------------|-------------------|-------------------|-------------------|
|                         |                  | coefficient       | t-ratio           | coefficient       | t-ratio           |
| YLD                     | +                | .5843             | 6.42*             | .5841             | 6.30*             |
| DER                     | +                | .4416             | .68               | .3359             | .51               |
| INC                     | +                | .2602             | 3.97*             | .2527             | 3.81*             |
| CLM                     | ?                | -.0795            | -1.23             | -.0617            | -.95              |
| LEXPI                   | +                | 4.4682            | 3.11*             | 174.53            | 2.67*             |
| ROE                     | +                | .1629             | 3.01*             | .1639             | 2.98*             |
| LRC                     | +                | .0323             | .29               | .0623             | .55               |
| Intercept               |                  | 4.0189            | 2.22              | 3.7295            | 2.02              |
|                         |                  | $R^2 = .62$       | $\bar{R}^2 = .59$ | $R^2 = .61$       | $\bar{R}^2 = .58$ |
|                         |                  | F = 17.56         | n = 82            | F = 16.70         | n = 82            |

### VITA

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