Lyon, Thomas P.; Mayo, John W.

Working Paper

Regulation and Investment Behavior: Evidence From the Electric Utility Industry

Working Paper, No. 128

Provided in Cooperation with:
George J. Stigler Center for the Study of the Economy and the State, The University of Chicago Booth School of Business

Suggested Citation: Lyon, Thomas P.; Mayo, John W. (1996) : Regulation and Investment Behavior: Evidence From the Electric Utility Industry, Working Paper, No. 128, The University of Chicago, Center for the Study of the Economy and the State, Chicago, IL

This Version is available at:
https://hdl.handle.net/10419/262530

Working Paper No. 128

REGULATION AND INVESTMENT BEHAVIOR: EVIDENCE FROM THE ELECTRIC UTILITY INDUSTRY

Thomas P. Lyon

John W. Mayo

Center for the Study of

the Economy and the State

The University of Chicago

REGULATION AND INVESTMENT BEHAVIOR: EVIDENCE FROM THE ELECTRIC UTILITY INDUSTRY*

Thomas P. Lyon

University of Chicago, and
Indiana University

John W. Mayo

University of Tennessee

PRELIMINARY DRAFT

July 1996

---

*We would like to thank David T. Mayes and Robert Book for excellent research assistance, Bill Bumpers for helpful discussions in the formulation of this paper, and Steven C. Peck and seminar participants at the University of Chicago, Louisiana State University, and the Rutgers Advanced Workshop in Public Utility Economics for helpful comments. The authors would also like to acknowledge the Indiana University School of Business, the Center for the Study of the Economy and the State at the Graduate School of Business at the University of Chicago, and the Center for Business and Economic Research at the University of Tennessee for financial support for this research.

Regulation and Investment Behavior: Evidence from the Electric Utility Industry

Thomas P. Lyon and John W. Mayo

Abstract

It is frequently asserted that changes in regulatory practice during the 1980s, e.g. the refusal to allow utilities full cost recovery for expensive nuclear power plants, have undermined incentives for investment by electric utilities. We offer the first empirical test of this proposition, by estimating an investment function for a sample consisting of 156 electric utilities over the period 1970-1991. We find that a utility that suffers a regulatory cost disallowance does indeed subsequently reduce its propensity to invest. Other utilities in the same state and in neighboring states, however, show no change in their investment behavior. Disallowances thus appear to punish bad behavior by particular utilities, but do not appear to signal a shift in regulatory practice. We also find that legal requirements that utilities purchase power from non-utility generators have significantly reduced the propensity of utilities to build their own generation sources. Finally, we find that accelerator-type determinants of investment have tended to dominate the effects of capital cost considerations as drivers of utilities' propensities to invest.

I. INTRODUCTION

In the mid-1980's, public utility commissions disallowed roughly $19 billion in electric power plant investments that would otherwise have become part of the utilities' rate bases. In response, industry members and some industry observers have alleged that the implicit "regulatory contract" between regulators and the regulated firms has been broken by opportunistic regulators.[1] Specifically, it was argued that under the traditional regulatory contract, regulators provided the regulated firm with monopoly protection and an assurance of the opportunity to earn a fair return on prudently invested capital and, in return, the regulated firm submitted to rate regulation and a common carrier obligation to fully satisfy consumer demand at prevailing prices. From this perspective, the large-scale disallowances amounted to purely opportunistic "hindsight" review wherein regulators reneged on their end of the regulatory contract after it was seen---with 20-20 hindsight---that fundamental demand and supply conditions had shifted. As a result of the abrogation of the regulatory contract, so the argument goes, utilities would become reticent, if not openly resistant, to further investment activities and the result would be large-scale supply shortages.[2]

Some support for this industry perspective may be inferred from a small theoretical literature including papers by Lyon (1991), Gal-Or and Shapiro (1992), and Gilbert and Newbery (1994). Although each of these papers adopts a somewhat different modelling process, all of these papers may be construed as suggesting that the conversion to regulatory hindsight review will reduce the investment propensities of regulated firms.

A key feature of the literature to date, however, is that it does not typically distinguish between firms that are engaged in efficient investment activities from those that are over-investing. Moreover, the literature does not incorporate the fact that regulators typically deal with multiple firms that may have different expectations regarding future demand growth or the likelihood of *ex post* cost disallowances. Nor does it allow

---

[1] Typical of the criticism of the power plant disallowances is Kahn (1986). The modern analysis of the regulatory "contract" originates with Goldberg (1976) and has been elaborated by Williamson (1985).

[2] See, e.g., Joskow (1989, p. 161), who claims that as a consequence of power plant disallowances "[f]ew utilities appear willing to build large base-load facilities, even in areas where additional capacity is needed." See also Navarro (1985), Kalt, Lee, and Leonard (1987), Pierce (1991), and Kolbe and Tye (1991).

for different regulatory treatment of these different types of firms. Thus, while these models provide considerable insights into the potential effects of a regulatory regime shift, they are limited in their ability to determine when or whether, in fact, such a shift in regulatory regimes has occurred.

In the debate surrounding the disallowances of the 1980's, this lacuna is particularly acute because a number of industry observers have argued that the emergence of large-scale power plant disallowances was not an abrogation by regulators of the regulatory contract, but rather a reflection of regulators fulfilling their obligations when confronted by some electric utilities that "misbehaved." From this perspective, managers of some specific electric power companies exercised particularly poor judgment in the development of their investment plans with the result that billions of dollars of excessive costs were incurred in investment activities to bring power plants online in the 1980s. Thus, it is argued that to the extent that electric utility investment has declined in recent years, the reasons have more to do with a slowdown in demand growth, excess capacity, and increased costs of power plant construction than with the breakdown of the regulatory contract.[3]

In this paper, we present a model of regulator-firm interaction. The model is built upon relatively simple and intuitive characterizations of the firm and the regulator. In particular, we allow for multiple regulated firms that have potentially different expectations regarding the prospects that regulators will punish the firm through *ex post* cost disallowances should the firm's base capacity deviate substantially from realized demand levels. Firms may also differ in their expectations of future demand levels. Moreover, we allow firms to update their beliefs about regulator type through observations of regulatory decisions that apply to other regulated firms. The results point toward an empirical model that is capable of distinguishing between the "violation of the regulatory contract" proposition that has been advanced by the industry and the "bad managerial judgment" proposition that has been alternatively suggested. Such an empirical model is constructed

---

[3] Zimmerman (1988) argues that recent regulatory treatment of cancelled nuclear power plants has been similar to that afforded manufactured natural gas plants that were abandoned in the 1950s, with regulators typically allowing recovery of but not a return on the investment, and with amortization typically occurring over a 10-year period. This suggests at least the possibility that incumbent electric utilities would have already accounted for the potential of partial cost disallowances, and that, accordingly, the realization of such disallowances in the 1980s would have no effect on realized investment propensities.

for electric utility investment decisions for the 1970-1991 period.[4] Using panel data involving 156 electric utilities, we first examine the general investment tendencies of these firms; then we turn to a regression-based model of utility investment. The results indicate that a utility that suffers a regulatory cost disallowance does indeed subsequently reduce its propensity to invest. Other utilities in the same state and in neighboring states, however, show no change in their investment behavior. Disallowances thus appear to punish bad behavior by particular utilities, but do not appear to signal a shift in regulatory practice.

The paper is organized as follows. In Section II, we provide a conceptual framework for our analysis by first identifying the nature of regulatory cost disallowances and the extant theoretical research regarding those disallowances. Next, we construct a simple model of utility investment decisions that permits the regulated utility to chose between investment and purchased power in a regulatory environment where investment costs may be disallowed. Several potentially important determinants of electric utility investment arise from this model. Then, in Section III, we turn to an empirical analysis of electric utlity investment decisions for the 1970-1991 period. Using panel data involving 156 electric utilities, we first examine the general investment tendencies of these firms; then we turn to a regression-based model of utility investment. Section III also reports the results of our empirical analysis. Finally, Section IV concludes the paper.

II. CONCEPTUAL FRAMEWORK

A. The Structure of the Regulatory Contract. The traditional regulatory process determines utility revenues in a series of three steps. First, regulators determine what operating costs are to be recovered in rates.[5] Most operating costs are passed directly into rates, though some categories such as advertising or purchases from affiliated subsidiaries may receive special treatment. Second, the capital stock or "rate base"

---

[4] Peck (1974) presents a pioneering estimation of the investment function for electric utilities, but for a much earlier time period with fewer demand and cost shocks, less dramatic regulatory action, and more rapid plant construction. As a result of the different economic environment during our sample period, Peck's methodology is not directly appropriate for our purposes.

[5] These include such items as wages, salaries, fuel costs, maintenance, advertising, research, depreciation and taxes.

(depreciated value of tangible and intangible property) is ascertained. The rate base includes only investments that are "prudently incurred" and that are "used and useful" in providing a particular utility's services. Third, the allowed rate-of-return on capital is determined. This rate must be commensurate with that earned by unregulated entities of comparable risk, and must preserve the utility's access to capital markets. The net revenue requirement is then the sum of operating costs plus the product of the rate base times the allowed rate of return.[6]

The cost disallowances discussed in the preceding section have typically been part of the second step mentioned above, the determination of the utility's rate base. From 1980 through 1991, roughly $19 billion was disallowed from various utilities' rate bases. The bulk of these disallowances were for management imprudence, but major disallowances have also been made on the basis of excess capacity (which is not used and useful), and of economic value (in retrospect, alternative sources of power would have been cheaper). It is worth noting that an investment can be "prudent" *ex ante* (based on the information held by managers at the time the investment was made) but not "used and useful" or of maximum "economic value" *ex post* (given the economic circumstances when the project is completed). Regulators clearly have discretion over the criteria to which they will hold a given investment.

In practice, it is the application of the retrospective criteria which have been most controversial. Both the used and useful test and the economic value test have been examined in the theoretical literature on regulation. The analyses of these rules generally start from the observation that overinvestment would tend to occur if the regulator were required to provide the firm a fair rate of return on all investment, regardless of its value in use. Gal-Or and Spiro (1992) consider a static setting with two utilities facing uncertain demands, each of which can sell power to the other if it has a capacity surplus. While the use of ROR regulation gives incentives to overinvest, each firm also has an incentive to free-ride on the other's costly capacity. On balance, the ROR effects dominate the free-riding effects, and without the threat of

---

[6] For a more detailed discussion of rate-of-return regulation in theory and practice, see Kaserman and Mayo (1995).

disallowances, the firms overinvest. Used and useful requirements help reduce, but cannot in general eliminate, excess capacity.

The "economic value" criterion has been modeled by Lyon (1991), who presents a static model where the regulator allows the firm to recover no more than the lowest "avoided cost" for an alternative plant, as judged *ex post* with perfect hindsight. The firm chooses between a "safe" project with known costs, or a "risky" project with uncertain costs; demand is known with certainty. Without the possibility of disallowances, the firm may have incentives to overinvest in the risky project. When the firm anticipates the application of the economic value criterion, it shifts to smaller, less risky projects. As long as the expected cost of the risky project is no less than that of the safe project, underinvestment does not occur.[7]

Gilbert and Newbery (1994) examine "used and useful rate-of-return regulation" (UUROR) in a repeated game where demand moves randomly over time. An equilibrium with efficient investment requires that the regulator develop a reputation for allowing a high rate of return when all capacity is used and useful, in order to compensate for the low rate of return earned in demand states where not all capacity is UU. If alternative sources of power are cheap, however, the regulator may have incentives to severely disallow excess capacity, despite the fact that such an action induces the utility to retaliate by underinvesting in all subsequent periods. The model thus predicts that an "opportunistic" disallowance will be followed by underinvestment, but an "efficient" disallowance will not.

All three of the above models provide efficiency rationales for the use of *ex post* disallowance criteria. From an empirical perspective, the static models of Gal-Or and Spiro (1992) and Lyon (1991) indicate that a shift in regulatory regime that suddenly allows the use of cost disallowances would be associated with

[7] Lyon (1995) shows that if the risky project has lower expected costs than the safe project---as might be expected for process innovations---then underinvestment may occur.

reduced investment by utilities.[8] The dynamic model of Gilbert and Newbery (1994) allows for a more precise distinction between efficient and opportunistic disallowances.

B. A Simple Structural Model. To structure our analysis, we develop a simple long-run model of utility investment decisions that captures the basic elements of disallowance policy discussed above. The utility can invest in generation capacity and/or it can purchase power from third party generators.[9] Investments deemed allowable by the regulator are placed in the firm's rate base, on which the utility is allowed to earn a return; fuel costs and purchased power, on the other hand, are expenses that are passed through directly into customer rates. At the time investments are made, the utility faces two uncertainties: 1) it is uncertain about future demand, and 2) it is uncertain about future regulatory policy. In particular, it is not sure whether the regulator will adopt a lenient policy of allowing all investment into the rate base, or a tough policy of allowing only investment that is used and useful into the rate base.

We assume perfectly inelastic demand, so that excess capacity is defined unambiguously. We also assume that non-utility power must by law be purchased by the utility, and that the utility has a legal obligation to meet all demand at regulated rates. In states of the world where demand exceeds the utility's own capacity plus its contracted-for levels of non-utility power, the firm can purchase power from other utilities at a per-unit price t. However, since we assume the cost of purchased power is passed through directly into customer rates, this cost does not appear directly in the expressions for expected profits presented below.

We use the following notation:

---

[8] Lyon's (1995) analysis also generates hypotheses about the extent of innovation by utilities, but the exploration of these is left for future work.

[9] We abstract from the complex reality that utilities can also engage in advertising (see Kaserman and Mayo (1985)) or invest directly in conservation (see Marino and Sicilian (1987)), both of which can lower demand and hence reduce the need for investment in generation plant. Data on conservation investments are available from the Energy
Information Administration for 1989 and subsequent years, however, they do not extend to the earlier periods covered by our dataset.

K = Initial generation capacity

δ = Rate at which capital depreciates

I = Investment in new capacity

x_0 = Initial demand

$x \in [\underline{x}, \bar{x}]$ = Future demand, a random variable

F(x) = Cumulative distribution on x, with corresponding density f(x)

N = Supply of non-utility power, which the utility is required to take

r = Rental cost of capital

s = Allowed rate of return

ρ = The probability, as assessed by the firm, that the regulator is lenient and allows all investment into the rate base

We begin by examining two polar cases, one where the firm is certain that the regulator is lenient, and the second where the firm is certain that the regulator is tough. In the first of these, the *unrestricted rate base* case, the regulator is assumed to allow full cost recovery on investment so long as $I \le \bar{x} - (1-\delta)K - N$, in which case profits are $\pi = (s-r)[(1-\delta)K + I]$. Assuming $s \ge r$, the firm's optimal investment is then $I^{RB} = \bar{x} - (1-\delta)K - N$.

Our second case depicts *used and useful* regulation, wherein the regulator allows a return on investment only for $I \le x - (1-\delta)K - N$. Any portion of investment beyond this bound is not allowed into the rate base. Now the firm's profits depend on the level of investment relative to observed demand:

$$\pi^{UU} = \begin{array}{l} sx - r[(1-\delta)K + I] \text{ if } I \le x - (1-\delta)K - N \\ (s-r)[(1-\delta)K + I] \text{ if } I > x - (1-\delta)K - N \end{array}$$

Expected profits are

$$\Pi^{UU} = \int_0^{(1-\delta)K+I+N} [sx - r[(1-\delta)K + I]] f(x)dx + \int_{(1-\delta)K+I+N}^{\bar{x}} (s-r)[(1-\delta)K + I] f(x)dx.$$

The firm's first-order condition for investment is then

$$s[1 - F((1-\delta)K + I + N)] = r.$$

Letting $C = x_0/K$ represent current capacity utilization, we can rewrite the first-order condition as

$$F[x_0 + K(1-\delta-C) + N + I] = 1 - r/s.$$

With these polar cases fixed, we turn to the more general case where the firm places positive probability on both possible regulatory postures. Expected profits become

$$\begin{aligned}\Pi = {} & \rho(s-r)[(1-\delta)K+I] \\ & + (1-\rho)\left[\int_0^{(1-\delta)K+I+N} [sx - r[(1-\delta)K+I]]\, f(x)dx + \int_{(1-\delta)K+I+N}^{\bar{x}} (s-r)[(1-\delta)K+I] f(x)dx\right]\end{aligned}$$

The firm's first-order condition for investment, which is illustrated in Figure 1, is then

$$F[x_0 + K(1-\delta-C) + N + I] = \left(1 - \frac{r}{s}\right)\left(\frac{1}{1-\rho}\right).$$

Totally differentiating the first-order condition, it is easy to derive a number of comparative static hypotheses regarding investment. First, since $\partial I/\partial K = C - (1-\delta)$, investment can either increase or decrease with the size of the current capital stock, depending on whether capacity utilization is greater or less than the fraction of capital

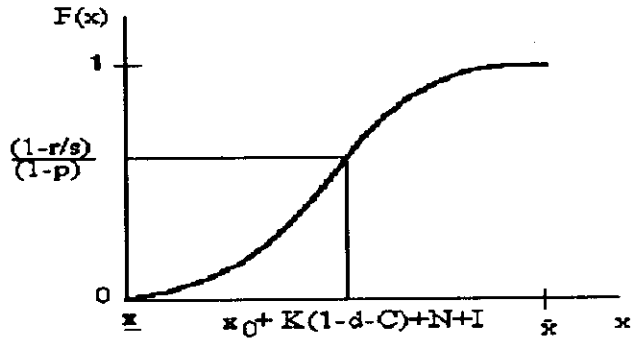


Figure 1: The Firm's Capacity Choice

that persists from one period to the next (which we refer to as the "capital persistence factor"). Second, since $\partial I/\partial C = K > 0$, investment increases with capacity utilization. Third, since $\partial I/\partial N = -1$, investment decreases with the supply of non-utility power. Fourth, since $\partial I/\partial r = -1/[s(1-\rho)F'(\cdot)] < 0$, investment decreases with the cost of capital. Finally, because $\partial I/\partial s = r/[s^2F'(\cdot)(1-\rho)] > 0$, investment increases with the allowed rate of return. We record these observations as Hypothesis 1.

Hypothesis 1: Investment (a) increases with the existing capital stock iff capacity utilization is greater than the capital persistence factor, (b) increases with capacity utilization, (c) decreases with the supply of non-utility power, (d) decreases with the cost of capital, (e) increases with the allowed rate of return.

While these basic economic hypotheses help us in structuring an empirical model, our focus lies beyond them: we want to test alternative hypotheses about the nature of the regulatory relationship. We are particularly interested in how firms update their beliefs about the regulatory environment in which they operate. Since $\partial I/\partial \rho = (s-r)/[sF'(\cdot)(1-\rho)^2] > 0$, investment should increase with the firm's belief that the regulator is likely to allow an unrestricted rate base regime. The firm's beliefs, however, are unobservable. Instead of testing this prediction directly, we use our simple model to distinguish three hypotheses about the effects of regulation on investment, which we refer to as "regime shift," "bad luck," and "bad judgment."

The "regime shift" hypothesis reflects the oft-expressed view that the regulatory process went through a structural shift during the 1980s, the character of which was essentially a shift from the unrestricted rate base model to the used and useful model. In a sense, ρ went from zero to one (or at least increased) in states across the nation. The implication is that the representative firm's propensity to invest should have fallen over this time period. When a cost disallowance occurs in a given state, this signals a regime shift by that state's regulatory agency, and all firms in the state should reduce investment. There may also be informational spillovers to firms in other states that are nearby, but the expected sign of the spillover effect is unclear. On one hand, firms in an adjacent state might decide that their neighboring state's tougher stance portends tougher

regulation in their state as well, and therefore reduce investment. On the other hand, such firms might foresee no incipient regional trend in regulatory practice, and reason that reduced investment by their counterparts in the neighboring state creates new opportunities for other firms such as themselves to increase investment.

The "bad luck" hypothesis holds that firms knew cost disallowances were a possibility in unfavorable demand states, and made rational investments in the face of this possibility. The observation of a cost disallowance provides no new information. As a result, a cost disallowance has no impact on the propensity to invest of either the firm that was disallowed or any other firm.

The "bad judgment" hypothesis holds that some firms perform better than others, and that good performers may react to regulatory actions in different ways than poor performers. In our model, we can think of firms as differing in their judgment about ρ. Consider two firms subject to the same regulator, the first of which believes $\rho = 0$ and the second of which believes $\rho = 1$. The former would embark on a less aggressive investment program than the latter. If a cost disallowance occurs, the first firm does not change its beliefs or its investment pattern, but the second firm scales back its investment.

Combining the above possibilities, we record our second set of predictions.

Hypothesis 2: Cost disallowances may affect subsequent investment behavior in several different ways. (a) If disallowances reflect a regulatory regime shift, then all firms subject to the same state regulator should reduce investment after a disallowance in that state. (b) If disallowances reflect bad luck, e.g. unexpectedly low demand, then they should have no effect on any firm's subsequent propensity to invest. (c If disallowances are imposed on firms that display bad managerial judment, e.g. firms that overbuild, then these firms should reduce their propensity to invest after a disallowance, but other firms should show no change in investment propensity.

The above hypotheses regarding investment form the conceptual foundation from which we begin building an empirical model of electric utility investment in the next section.

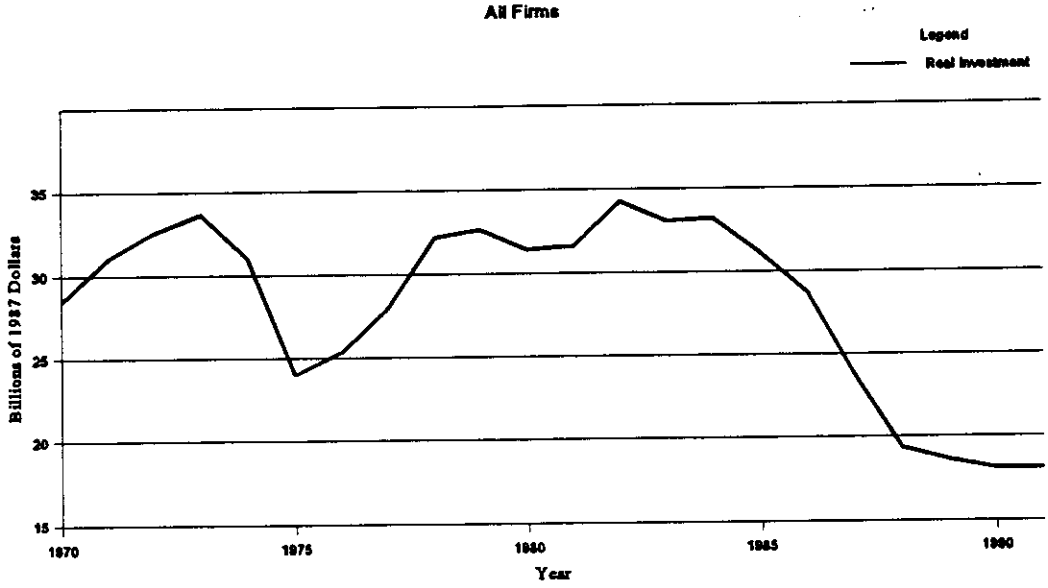
III. The Empirical Determinants of Electric Utility Investment

In the previous section, we developed a stylized model of utility firm investment in the face of incomplete contracting. The theoretical model provides important guidance on the prospective determinants of utility firm investment, however, the model is not capable of determining the relative importance of specific determinants. Moreover, the model is devoid of the institutional detail required of an empirical model of a major industry in which important public policy constraints have been modified over time. Accordingly, we now turn to the development of such a model that draws upon both the theoretical insights generated from the previous section and the inclusion of industry specific institutional factors that are likely to have affected industry investment over the past twenty years.

A. Background and Data. Our empirical analysis of electric utility investment covers the period from 1970-1991. In particular, we examine investment in the form of gross additions to electric utility plant for a sample of 156 electric utilities that operate in the 48 contigous states. These firms constitute the entire set of electric utilities for which continuous investment data were reported in the U.S.Energy Information Administration's Finanicial Statistics of Selected Electric Utilities. The sample firms represent 92% of total

industry sales to final customers in the United States and 91% of industrywide generation. Figure 2 provides a graph of inflation-adjusted electric utility investment over time. Two features of Figure 2 stand out. First, the total dollar volume of electric utility investment in any given year is quite high. For example, in 1987, the sample firms invested roughly 23.8 billion, or an average of 152.7 million per firm. The extraordinary degree of capital intensity of the industry is further underscored by noting that the total dollar value of electric utility plant in place in 1987 was $475 billion while the value of electricity sales was $139 billion.[10] Second,

Figure 2: Real Investment by Electric Utilities, 1970-1991

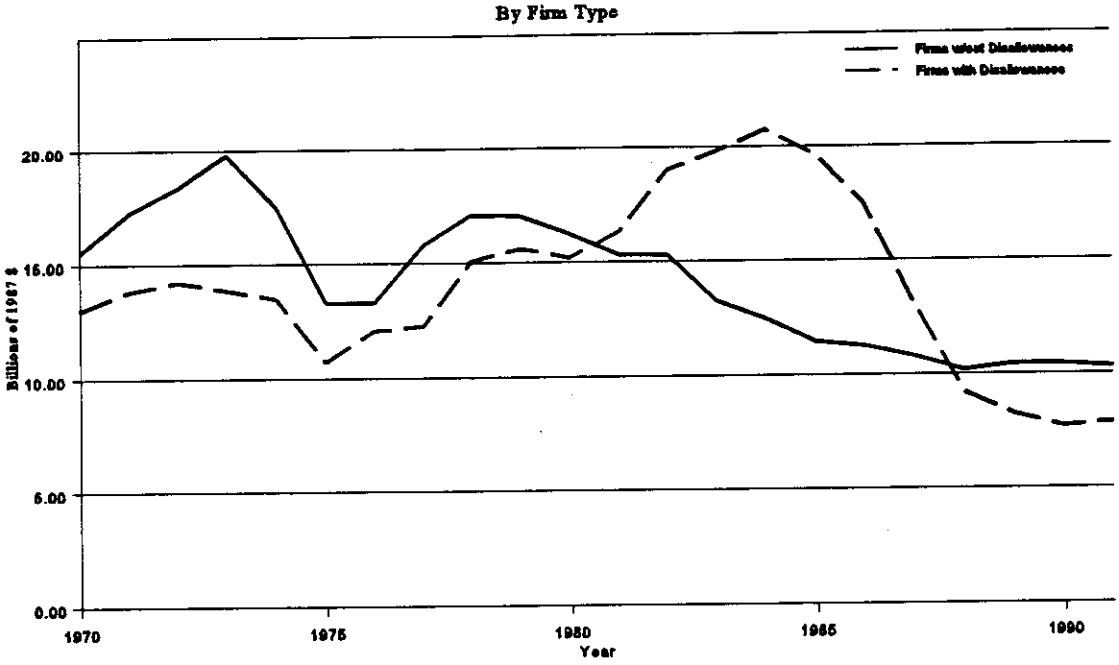


it is easy to see in Figure 2 that the real dollar volume of electric utility investment peaked in the early 1980s and fell precipitously between 1985 and 1991.

[10] See Financial Statistics of Selected Electric Unilities, Energy Information Administration, U.S. Department of Energy, 1987.

Figure 3 bifurcates the sample firms into those that incurred regulatory cost disallowances and those that did not. Again, the graph is quite revealing. Real investment by electric utilities that ultimately were not penalized with regulatory cost disallowances peaked in 1973 and declined more or less continously thoughout the subsequent period. In contrast, firms that ultimately suffered a cost disallowance are seen to have increased investment markedly from 1975 through 1984, after which investment spending declined sharply.

Figure 3: Real Investment by Electric Utilities, 1970-1991



The potential for regulatory cost disallowances is as old as regulation itself.[11] While some cases of electric utility cost disallowances were observed over the years, it was not until the mid-1980s that significant dollar volumes of cost disallowances began to occur. Typical disallowances during the mid-1980s amounted

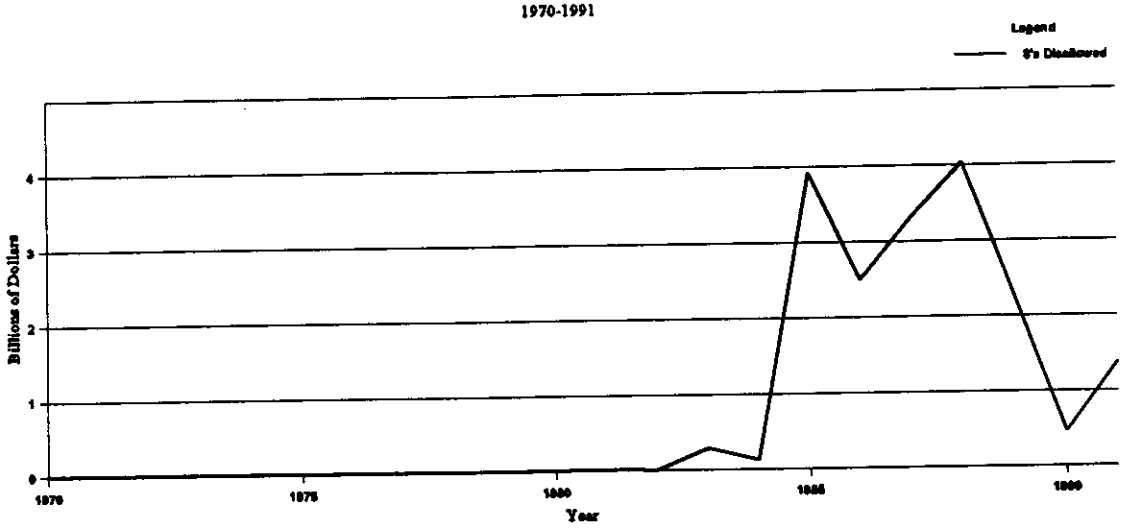
[11] See Kahn (1988) for a thorough historical discussion of the legal and economic issues surrounding regulatory cost disallowances.

to hundreds of millions of dollars and in two cases (the Nine Mile Point 2 unit in New York state and the Diablo Canyon plant in California) regulatory cost disallowances were $2 billion or greater.[12] As noted in Section II above, these disallowances have generally taken one of several forms. First, under the "prudent investment" rule construction costs determined to be imprudent are not allowed to be recovered from ratepayers. Second, under the "used and useful" rule regulators have allowed the recovery of costs only for that part of the capital stock that is demonstrated to be used and useful. The costs associated with excess capacity, however, have not been permitted. Third, in the mid-1980s regulators began to apply a standard of "economic value" to determine whether investment costs incurred by electric utilities would be permitted to be included in the companies' rate bases. Under the economic value standard, regulators have allowed the firm to recover no more than the lowest cost for an alternative plant, as judged with perfect hindsight. Figure 4 provides the total dollar volume of regulatory cost disallowances for the sample firms from 1970-1991. There we see that virtually all regulatory cost disallowances occurred beginning in the mid-1980s. Cumulatively, over 50 separate dissallowances on 37 different generating units were observed in the sample

[12] See Table 1 for a list of the largest cost disallowances on a plant-by-plant basis.

period, with a total dollar volume of disallowances of over $19 billion.[13] A complete list of disallowances on a generating unit basis is given in Table 1.[14]

Figure 4: Dollar Volume of Regulatory Disallowances
1970-1991



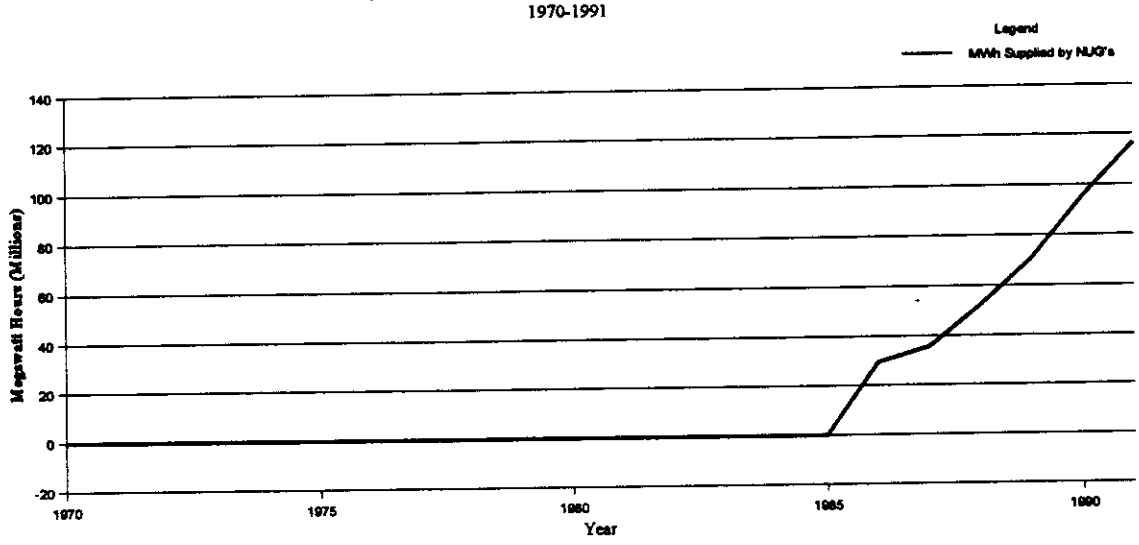
[13] Our data on cost disallowances are drawn from four sources. Oak Ridge National Laboratory (1987) inventories all disallowances in the United States over the period 1980 - 1986, for nuclear, coal, and other types of plants. The study classifies the reason for each disallowance, drawing from five categories: imprudence, excess capacity, economic value, cost caps, or other. U.S. Department of Energy (1989) updates the data through 1988. LeBoeuf, Lamb, Leiby and MacRae (1991) provide an independent accounting of nuclear disallowances that extends from 1980 through 1990. Anderson (1991) gives another list of nuclear plant disallowances.

These four sources sometimes disagree on the dollar amount of disallowances, and in combining them we have generally placed more credence in data gathered more recently and reported in more detail. There are several potential reasons for disagreement about the dollar value of a particular disallowance. First, disallowance cases often drag on for a number of years, and earlier decisions may be altered later. The Oak Ridge study sometimes notes that a particular case is under regulatory review, but can provide no dollar value disallowed. Thus, we use the data from the most recent source in such cases. Second, a particular plant may be jointly owned by several utilities. The Department of Energy study sometimes reports only an aggregate disallowance for the plant, and Anderson sometimes reports only a particular firm's disallowance for a given plant; in these cases we have relied on the LeBoeuf et al. data, which break down disallowances by company ownership. Third, a disallowance may be effected by such means as phasing capacity into the rate base over time or by subjecting the plant to regulatory incentives designed to induce its efficient operation. In such cases, it is difficult to accurately calculate the net present value of the effects of a disallowance decision. In these cases, we have restricted ourselves to recording only the specific dollar amount disallowed from ratebase by the regulator. One exception is the Diablo Canyon plant built by Pacific Gas and Electric, which is being operated under an incentive regulation plan which all parties appear to agree generated a net present value of disallowance of $2 billion at the time the plan was implemented. The total amount disallowed from nuclear plants from 1980 - 1991 was $18.335 billion, while the total disallowed for coal and other plants was $781.915 million.

[14] In cases where a plant is owned by multiple firms, the table reports only the aggregate disallowance for the plant.

Aside from regulatory cost disallowances, the major public policy change in the electric utility industry during the sample period stemmed from the passage of the Public Utilities Regulatory Policies Act (PURPA), which was part of the more comprehensive National Energy Act of 1978. The purpose of PURPA, in part, was to encourage the efficient use of fossil fuels through the growth of cogenerated power and the use of renewable resources such as solar, wind, or biomass to generate electricity. A key feature of PURPA

Figure 5: Power Supplied by Non-Utility Generators
1970-1991



is a requirement that electric utilities interconnect with and purchase power from any "qualifying facility."(QF)[15] Moreover, PURPA requires that the incumbent utility buy power from qualifying facilities at the utility's own avoided costs. The combination of mandatory interconnection and the requirement to purchase power from QFs at the utility's avoided costs ensures that these fringe suppliers have a market for

[15] PURPA defines two types of qualifying facilities: (1) cogenerators that sequentially produce electricity and another form of energy (e.g., steam) using the same fuel source: and, (2) small power producers that use waste, renewable, or geothermal energy as a primary energy source. These power producer are qualified under PURPA by meeting various ownership, operating, and efficiency conditions that are established by the Federal Energy Regulatory Commission. See 42 U.S.C. Section 824 a-3 (Supp. 1988). These qualifying facilities account for roughly three quarters of all nonutility power generation, while non-qualifying facilities (e.g., a plant that produces only electricity using conventional fossil fuel sources) account for the remainder. For a more detailed discussion of the nature and output from these nonutility generators, see Energy Information Administration (1993).

their electricity. Because the magnitude of "avoided costs" was initially set by fiat at what many consider to be relatively lucrative rates,[16] rather than through a competitive bidding process, and because QFs are not cost-of-service regulated, the amount of investment in electricity-producing cogeneration and small power producing facilities by non-utilities grew rapidly during the latter part of the 1980s. For our sample, Figure 5 reveals that power supplied by nonutility generators grew from zero to 116.7 million megawatthours in a mere six years. Moreover, this growth in supply from nonutility generators is expected to continue. The Energy Information Administration anticipates that fully one-half of all net additions to generating capacity through the 1990's will come from nonutility electric generating facilities.[17]

B. The Empirical Model and Estimation Results. Given the standard common carrier obligation facing utilities, our baseline empirical model specifies that investment of electric utilities is driven by a desire to fulfill expected demand with the available capital stock. Thus, we specify investment (I) by utility i in time t as,

$$I_{i,t} = \beta_0 + \beta_1(\mathbf{CAPSTOCK})_{i,t-1} + \beta_2(\mathbf{CAPUTIL})_{i,t} + \epsilon_{it}, \qquad (1)$$

where **CAPSTOCK** is the stock of capital and **CAPUTIL** is the level of capacity utilization. The stock of capital is included to account for replacement investment and as discussed in section II, we expect that β_1 will be positive if capacity utilization is greater than the capacity persistence factor.[18] The level of capacity

---

[16] See, for example, Joskow (1989), p. 174.

[17] See The Changing Structure of the Electric Power Industry, 1970-1991. Energy Information Administration, Office of Coal , Nuclear, Electric and Alternative Fuels, U.S. Department of Energy, Washington, D.C., March 1993.

[18] See Jorgenson and Handel (1971). More generally, see Jorgenson (1971) for a survey of models that similarly account for replacement investment.

utilization is included to account for the proximity of the firm to the realization of capacity constraint, so we expect β_2 to be positive.[19]

To account for the influence of other factors that may influence electric utility investment, we specify that the sensitivity of investment to changes in **CAPUTIL** is itself dependent on a variety of explanatory variables, X. That is,

$$\beta_2 = \gamma_0 + \sum \gamma_i X_{i,t}. \qquad (2)$$

This specification of β_2 allows us to examine how the sensitivity of the investment-capacity utilization relationship varies with economic and institutional factors, including the emergence of large-scale cost disallowances that developed in the mid-1980s. Several variables are included in the X-vector. First, consistent with accelerator models of investment, we include **DEMF3AV**, the average realized value of end-user retail electricity sales over the subsequent three years to account for the level of anticipated demand.[20] Next, we include the amount of electric power supplied by nonutility generators, **SUPLYNUG**, to account for the impact of the PURPA legislation that requires incumbent utilities to purchase nonutility generators'power. Because this nonutility generator power can be used to satisfy consumer demand in lieu of investment activities by the incumbent utility, we expect that **SUPLYNUG** will negatively influence the investment propensities of incumbent utilities. Consistent with both standard investment theory and the model specified in Section II above, we include **CAPCOST** as an explanatory variable. We also include a measure of the amount of purchased power from other utilities in the model, **SPLYUTIL**. To the extent that purchased power is more expensive than self-generated power, higher values of **SPLYUTIL** are likely to indicate capacity constraints that are unaccounted for in our industry-wide measure of capacity utilization. Accordingly, we expect higher values of **SPLYUTIL** to increase the investment propensity of electric utilities.

---

[19] This specification is consistent with anecdotal evidence suggesting that utility planners during this period were often driven in their investment decisions by the proximity of realized consumer demand to the available capacity.

[20] Our approach here is akin to Oliner and Rudebusch (1991), who include current sales. Given the longer planning horizon for electric utilities, we include a three year window of future sales.

Finally, several variables are included in the specification of equation (2) to account for the nature of regulatory cost disallowances that were imposed on some of the electric utilities in our sample. First, we include a firm-specific indicator variable, **DALLOW**, to account for whether the firm in question has been subjected to a regulatory cost disallowance in any previous period. Second, we account for the potential impact that regulatory cost disallowances may have on other utilities operating in the same state. Specifically, we include an indicator variable, **DALLOWST**, whose value is one when a utility in the same state has previously faced a regulatory cost disallowance and zero otherwise. Finally, we include an indicator variable to account for the potential impact a disallowance may have on the behavior of utilities in adjacent states. That is, if a firm operating in a state j is assessed a regulatory cost disallowance, then the indicator variable for utilities in adjacent states, **DALLOWNST**, subsequently takes on values of unity, and zero otherwise. As an alternative measurement of regulatory cost disallowances, we specify disallowances in terms of their cumulative dollar values. (**CUMDIS**, **CUMDISST**, **CUMDISNST**). A complete listing of the model's variables along with their simple descriptive statistics is provided in Table 2.

Combining (1) and (2), then, our model specification is given by

$$I_{i,t} = \beta_0 + \beta_1(\mathbf{CAPSTOCK})_{i,t} + \gamma_0(\mathbf{CAPUTIL})_{i,t} + \gamma_1[(\mathbf{DEMF3AV})_{i,t}*(\mathbf{CAPUTIL})_{i,t}] + \gamma_2[(\mathbf{SUPLYNUG})_{i,t}*(\mathbf{CAPUTIL})_{i,t}] + \gamma_3[(\mathbf{SPLYUTIL})_{i,t}*(\mathbf{CAPUTIL})_{i,t}] + \gamma_4[(\mathbf{CAPCOST})_{i,t}*(\mathbf{CAPUTIL})_{i,t}] + \gamma_5[(\mathbf{DALLOW})_{i,t}*(\mathbf{CAPUTIL})_{i,t} + \gamma_6[(\mathbf{DALLOWST})_{i,t}*(\mathbf{CAPUTIL})_{i,t}] + \gamma_6[(\mathbf{DALLOWNST})_{i,t}*(\mathbf{CAPUTIL})_{i,t}] + \epsilon_{i,t}. \quad (3)$$

As noted above, two alternative specifications of the disallowances are estimated. First, as shown in equation (3), we include a set of indicator variables that account for whether a potentially relevant disallowance has occurred. Second, we allow for the possibility that the cumulative magnitude of disallowances may affect the propensity of utility investment. Given the combined time-series and cross-sectional nature of the data, Equation (3) was estimated using an error components model that allows for the error term to include not only

a standard random element but also both a time-specific error component and a firm-specific error component.[21] For purposes of comparison, the models are also estimated using ordinary least squares.[22]

Overall, the estimation results, reported in Table 3, are very encouraging. Both the F-value and the adjusted R^2s indicate the aggregate strength of the empirical models. Moreover, the individual parameter values and their statistical significance provide specific insight into the particular determinants of electric utility investment propensities. As hypothesized, both the level of capital stock (**CAPSTOCK**) and the level of capacity utilization (**CAPUTIL**) are positive determinants of electric utility investment. Also, we find that the future level of demand for retail-level power (**DEM3AV**) is a key determinant of electric utility investment. Next, we find that the supply of nonutility power (**SUPLYNUG**) that arose in the wake of PURPA has been a powerful factor that has significantly reduced the propensity of incumbent electric utilities to invest. The error components estimates indicate that higher purchases from other (non-NUG) utilities heightens the firm's propensity to invest in new plant and equipment. Our measure of capital cost performs less well. Our capital cost coefficient is the wrong sign though not significantly different from zero.[23]

We turn now to our second broad hypothesis, which concerns the appropriate interpretation of the effects of disallowances on investment behavior. As discussed in section II, we wish to discriminate between three hypotheses: (a) a regulatory regime shift, (b) bad luck on the part of some utilities, and (c) bad managerial judgment on the part of some utilities. We find that even after accounting for a variety of other factors that have influenced electric utility investment, utilities that have been subject to regulatory cost disallowances (for whom **DALLOW** is positive) have reduced propensities to engage in investment. This suggests that the disallowances were not simply the result of "bad luck," e.g. unfortunate draws from the

---

[21] See Battese and Fuller (1966).

[22] As a test of the robustness of our results to alternative model specifications, we also estimated a strict linear model with no interaction variables. No substantive differences emerge from the results reported here.

[23] The occurrence of a positive coefficient here suggests further inquiry, so this result should be viewed as very preliminary. One possible explanation is that if utilities are able to recoup capital costs in a timely fashion through rate cases, Averch-Johnson effects may prompt increased investment activity.

distribution of possible future demand levels. As discussed in section II, the "bad luck" hypothesis implies no shift in investment propensity. Utilities continue with their existing investment practices, recognizing that demand uncertainty means that some negative outcomes must be anticipated.

Turning to **DALLOWST** and **DALLOWNST**, the OLS results point toward support for the notion of a regime shift, since regulatory cost disallowances appear to contain a signaling value to other utilities about the characteristics of particular regulators. However, once the firm-specific and time-specific error structure is accounted for in the error components model, the estimation provides no such support. The error components results suggest that the impact of the disallowances on specific utilities was considered by other utilities to have been unique to the particular "offending" utilities. This lack of a significant "spillover" effect to other utilities suggests that the disallowances were not perceived by other utilities as a major regulatory regime shift.

We infer, given the above results, that the best interpretation of major cost disallowances is that they are a response to poor managerial judgment, rather than a reflection of bad luck or an opportunistic change of policy on the part of regulators.

IV. Conclusions

In this paper, we have made what we believe is the first attempt to empirically capture the effects of the large scale nuclear power plant disallowances that ocurred in the mid-1980s on electric utilities' investment propensities. At a more general level, this research provides additional insight into the relationship between regulatory regime shifts and consequent behavior by regulated firms. Although the research is presently at a preliminary state of development, several interesting results have emerged. First, we find that the empirical consequence of large-scale cost disallowances has been to reduce the investment propensities of the electric utilities that have experienced these disallowances. In the context of the Gilbert and Newbery (1994) model, this would provide evidence that regulators have been opportunistic in changing the rules used to evaluate electric utility investment, and that the affected utilities have responded by adopting a policy of reduced

investment. We are hesitant to draw this inference, however, since that model does not allow for the possibility that firms may deviate from the equilibrium path by overinvesting, in which case a disallowance might serve merely to bring the firm back down to an efficient level of investment. This possibility is allowed for in the model of section II above, and is also consistent with the observed reduction in investment propensity by utilities that have been disallowed. We can discriminate between the two interpretations by noting that utilities that have not experienced disallowances do not appear to have reduced investment. This suggests that regulatory commissions have different relationships with the different utilities under their jurisdiction, and that utilities that did not embark on excessive investment programs did not view disallowances as signalling a regulatory regime shift.

A second interesting finding is that the passage of PURPA, with its requirements for purchases of electric power from nonutility generators at the incumbent's "avoided cost," has had the effect of both motivating nonutility generation and reducing the propensity of incumbent firms to develop their own generation sources through investment. Finally, we find that accelerator-type determinants of investment tended, at least for the sample period, to dominate the effects of capital cost considerations as drivers of electric utilities' propensities to invest.

As with much empirical analysis, the present research has opened many paths for subsequent analysis, which we are only beginning to explore. For example, recent research has indicated that in some circumstances (especially, capital market informational asymmetries), the level of corporate cash flows may impact the level of observed investment.[24] Given the widespread knowledge regarding the nature and accounting information of firms in the electric utility industry, it is not at this point clear whether one ought to expect a "cash flow" effect. The possibility, however, seems worthy of exploration. Similarly, while our efforts to this point account for the effects of state-level regulatory cost disallowances, we have not yet explored the potential effects of other state level regulatory factors (e.g., length of Commission terms) on

---

[24] See, e.g., Hoshi, Kashyap and Scharfstein (1991) and Hubbard and Kashyap (1992).

electric utility investement. These other considerations suggested by a broader inquiry into the political economy of the relationship between regulators and their regulated firms may emerge as statistically verifiable determinants of electric utility firm investment propensities. Another issue worth exploring is how regulatory adaptations have affected the adoption of innovative generation technologies by utilities. The theoretical literature predicts that increased use of disallowances will change not only the level of investment activity but also the type of investments that are made (viz., toward smaller plants with less construction risk). Given the paucity of research on how regulation affects innovation, work in this area should be particularly interesting.

REFERENCES

Anderson, John A., "Are Prudence Reviews Necessary?," *Public Utilities Fortnightly*, February 1, 1991, pp. 23-26.

Energy Information Administration. *The Changing Structrue of the Electric Power Industry 1970-1991*, Office of Coal, Nuclear, Electric and Alternative Fuels, U.S. Department of Energy, Washington, D.C., March 1993.

Fuller, W. A. and Batesse, G.E. "Estimation of Linear Models with Cross-Error Structure," *Journal of Econometrics*, Vol. 2, 1974, pp. 67-78.

Gal-Or, Esther and Michael H. Spiro. "Regulatory Regimes in the Electric Power Industry: Implications for Capacity," *Journal of Regulatory Economics*, v.4, 1992, pp. 263-278.

Gilbert, Richard J. and David M. Newbery, "The Dynamic Efficiency of Regulatory Constitutions," *RAND Journal of Economics*, Winter 1994, v. 25, pp. 538-554.

Goldberg, Victor, "Regulation and Administered Contracts," *Bell Journal of Economics*, 1976, v. 7, pp. 426-452.

Hoshi, Takeo, Kashyap, Anil, and Daid Scharfstein. "Corporate Structure, Liquidity, and Investment: Evidence from Japanese Industrial Groups," *Quarterly Journal of Economics*, Vol. 106, pp. 33-60.

Hubbard, R. Glenn and Anil Kashyap. "Internal Net Worth and the Investment Process: An Application to U.S. Agriculture," *Journal of Political Economy*, Vol.100, pp. 506-534.

Jorgenson, Dale W. "Econometric Studies of Investment Behavior: A Survey," *Journal of Economic Literature*, Vol. 9, Number 4, pp. 1111-1147.

Jorgenson, Dale W. and Sidney S. Handel. "Investment Behavior in U.S. Regulated Industries," *The Bell Journal of Economics and Management Science*, Vol. 2, Spring 1971, pp. 213-264.

Joskow, Paul L. "Regulatory Failure, Regulatory Reform, and Structural Change in the Electrical Power Industry," *Brookings Papers: Microeconomics*, 1989, pp. 125-199.

Kahn, Alfred. *The Economics of Regulation: Principles and Institutions*. The MIT Press, Cambridge, MA., 1988.

Kahn, Alfred. "Who Should Pay for Power Plant Duds?," *The Wall Street Journal*, 198?.

Kalt, Joseph, H. Lee and H. Leonard, "Re-establishing the Regulatory Bargain in the Electric Utility Industry," 1987, Harvard University, Energy and Environmental Policy Center, Discussion Paper E-87-02.

Kaserman, David L. and John W. Mayo. *Government and Business: The Economics of Antitrust and Regulation*, Harcourt Brace, The Dryden Press, Ft. Worth, TX., 1995.

Kaserman, David L. and John W. Mayo. "Advertising and the Demand for Residential Electricity," *Journal of Business*, v. 58, October 1985, pp. 399-408

Kmenta, Jan. *Elements of Econometrics*. Macmillan, New York, 1971.

Kolbe, A. Lawrence and William B. Tye, "The *Duquesne* Opinion: How Much `Hope' is There for Investors in Regulated Firms?," *Yale Journal on Regulation*, 1990, v. 8, no. 3, pp. 113-157.

LeBoeuf, Lamb, Leiby, and MacRae. "State Regulatory Risk Factors Associated with Investment in the Next Commercial Nuclear Reactor Plant." Prepared for the Edison Electric Institute, June 1991.

Lyon, Thomas P. "Regulation with 20-20 Hindsight: Heads I Win, Tails You Lose?," *RAND Journal of Economics*, Winter 1991, pp. 581-595.

Lyon, Thomas P. "The Effects of Regulatory Hindsight Review on Innovation by Electric Utilities," *Journal of Regulatory Economics*, v. 7, 1995, pp. 233-254.

Mayo, John W. and Joseph E. Flynn. "The Effects of Regulation on Research and Development: Theory and Evidence," *Journal of Business*, v 61, no. 3, July 1988, pp. 321-336.

Navarro, Peter, *The Dimming of America*, 1985.

Oliner, S.D. and G. D. Rudebusch. "Sources of the Financing Hierarchy for Business Investment and Agency Costs," *Review of Economics and Statistics*, v. 74, 1992, pp. 643-654.

Peck, Steven C. "Alternative Investment Models for Firms in the Electric Utility Industry," *Bell Journal of Economics*, 5, Autumn 1974, pp. 420-458.

Pierce, Richard J., Jr., "The Unintended Effects of Judicial Review of Agency Rules: How Federal Courts have Contributed to the Electricity Crisis of the 1990s," *Administrative Law Review*, v. 43, 1991, pp. 7-29.

Oak Ridge National Laboratory. *Prudence Issues Affecting the U.S. Electric Utility Industry*, December 1987.

U.S. Department of Energy, *Prudence Issues Affecting the U.S. Electric Utility Industry, Update: 1987 and 1988 Activities*, February 1989.

Williamson, Oliver E. *The Economic Institutions of Capitalism*, (New York: The Free Press), 1985.

Zimmerman, Martin B. "Regulatory Treatment of Abandoned Property: Incentive Effects and Policy Issues," *Journal of Law and Economics* 31 (1988): 127-144.

Table 1: Largest Cost Disallowances by Plant

	UNIT	Fuel	UTILITY	Disallowed ($Million)	Year
1	Nine Mile Point 2	Nuclear	Multiple	2141.00	1987
2	Diablo Canyon 1&2	Nuclear	Pacific Gas & Electric Co.	2000.00	1988
3	Wolf Creek 1	Nuclear	Multiple	1617.60	1985
4	Shoreham 1	Nuclear	Long Island Lighting	1395.00	1985
5	Comanche Peak 1&2	Nuclear	Texas Utilities	1381.00	1991
6	Fermi 2	Nuclear	Detroit Edision Co.	1310.00	1988
7	River Bend 1	Nuclear	Gulf States Utilities Co.	1297.00	1987
8	Susquehanna 1&2	Nuclear	Pennsylvania Power & Light	847.00	1985
9	Clinton 1	Nuclear	Illinois Power Co.	665.00	1989
10	Perry 1	Nuclear	Multiple	665.00	1989
11	Seabrook 1	Nuclear	Multiple	646.40	1989
12	Vogtle 1&2	Nuclear	Georgia Power Co.	541.00	1987
13	Hope Creek 1	Nuclear	Multiple	511.60	1987
14	Callaway 1	Nuclear	Union Electric Co.	413.70	1985
15	South Texas 1&2	Nuclear	Houston Lighting & Power	375.50	1990
16	Limerick 1	Nuclear	Philadelphia Electric Co.	368.90	1986
17	Millstone 3	Nuclear	Multiple	353.00	1986
18	Waterford 3	Nuclear	Louisiana Power & Light	284.00	1987
19	Greenwood 1	FO#2	Detroit Edison	283.00	1986
20	Braidwood 1	Nuclear	Commonwealth Edison Co.	278.30	1988
21	San Onofre 2 & 3	Nuclear	Multiple	252.00	1987
22	Grand Gulf 1	Nuclear	Multiple	246.20	1988
23	Trimble County	Coal	Louisville Gas & Electric	200.00	1988
24	Palo Verde 1-3	Nuclear	Multiple	188.00	1988
25	Byron 2	Nuclear	Commonwealth Edision	180.60	1988
26	Beaver Valley 2	Nuclear	Multiple	125.30	1989
27	Summer 1	Nuclear	South Carolina Electric & Gas	123.00	1984
28	Hunter 3	Coal	Utah Power & Light	112.50	1986
29	Byron 1	Nuclear	Commonwealth Edision	101.50	1985
30	Belle River 1&2	Coal	Detroit Edison	96.87	1985
31	Bath County	PS	West Penn. Power	31.00	1987
32	Helms 1-3	PS	Pacific Gas & Electric	21.99	1985
33	Daniel	Coal	Mississippi Power	19.00	1981
34	Kettle Falls	Water	Washington Water & Power	9.00	1984
35	Reid Gardner 4	Coal	Nevada Power	4.37	1983
36	Big Bend 4	Coal	Tampa Electric Co.	3.68	1985
37	Holcomb 1	Coal	Sunflower Electric Power	0.50	1985
	TOTAL			19089.5	

TABLE 2
Descriptive statistics

Variable Name	Description	Mean	Std. Dev.	Minimum	Maximum	Source
$RINV_{i,t}$	Real investment (1987 $) by utility i in year t measured as gross additions to utility plant, deflated using the Handy-Whitman index of utility plant construction costs.	174,511,788	239,030,426	-22,785,194	1,722,670,075	1, 2
$CAPUTIL_t$	Capacity utilization in year t measured using the ratio of aggregate Mwh generation to aggregate nameplate capacity measured in Mwh.	.43	0.03	.39	.50	4
$CAPSTOCK_{i,t}$	Beginning of period real (1987 $) capital stock measured as net electric utility plant in year t - 1. Deflated using Handy-Whitman index.	1,218,276,227	1,902,420,380	1,159,727	17,733,727,310	1, 2
$DEMF3AV_{i,t}$	Demand forecast computed using the average realized value of sales in Mwh over years t + 1 to t + 3.	11,352,960	13,536,500	6,808	120,170,891	1
$SUPLYNUG_{i,t}$	Mwh supplied by non-utility generators measured as purchases by utility i from NUG's in year t.	60,246	675,935	-271,438	19,351,463	1
$CAPCOST_t$	The product of the financial cost of capital, as proxied by the prime lending rate, and the cost of constructing new facilities, as proxied by the Handy-Whitman index.	9.9705	3.3529	5.2500	18.8700	3
$DALLOW_{i,t}$	Dummy variable equal to one if utility has been subject to a regulatory disallowance prior to year t, zero otherwise.	0.0266	0.1609	0.00	1.0000	5
$DAALOWST_{i,t}$	Dummy variable equal to one if a utility in the same state as firm i has been subject to a disallowance prior to year t, zero otherwise.	0.0878	0.2831	0.00	1.0000	5
$DALLOWNST_{i,t}$	Dummy variable equal to one if a utility in a state bordering the state containing firm i has been subject to a disallowance prior to year t, zero otherwise.	0.1667	0.3727	0.00	1.0000	5

Sources: 1 = Financial Statistics of Selected Electric Utilities.
2 = Current Construction Reports, U. S. Dept. of Commerce.
3 = Survey of Current Business, U. S. Dept. of Commerce.
4 = Energy Information Administration (1993)
5 = Oak Ridge National Laboratory (1987), U.S. Department of Energy, (1989) and LaBeoeuf, et. al. (1991)

TABLE 3

ELECTRIC UTILITY INVESTMENT

	Model 1		Model 2	
Variable	Error Components	OLS	Error Components	OLS
Intercept	-1.13×10^{8} (-.95)	-1.67×10^{8}*** (-3.31)	-1.08×10^{8} (-.92)	-1.61×10^{8}*** (-3.22)
CAPSTOCK	.089*** (30.49)	.102*** (44.60)	.095*** (32.00)	.105*** (45.50)
CAPUTIL	3.14×10^{8} (1.21)	4.04×10^{8}*** (3.65)	3.04×10^{8} (1.19)	3.90×10^{8}*** (3.56)
DEMF3AV*CAPUTIL	6.17*** (5.60)	6.36*** (7.39)	4.67** (4.26)	5.24*** (6.05)
SUPLYNUG*CAPUTIL	-63.27*** (-8.24)	-62.11*** (-7.94)	-57.59** (-7.60)	-58.45*** (-7.51)
SPLYUTIL*CAPUTIL	5.79*** (3.20)	.378 (.248)	5.63*** (3.15)	0.48 (.317)
CAPCOST*CAPUTIL	-2.27×10^{6} (-.391)	4.36×10^{6} (1.69)	-2.26×10^{6} (1.69)	4.14×10^{6} (1.62)
DALLOW*CAPUTIL	-3.48×10^{8}*** (-10.30)	-3.10×10^{8}*** (-9.11)		
DALLOWST*CAPUTIL	-5.52×10^{6} (-.242)	-5.34×10^{7}** (-2.42)		
DALLOWNST*CAPUTIL	-3.05×10^{7} (-1.51)	-1.27×10^{8}*** (-7.99)		
CUMDIS*CAPUTIL			-.615*** (-14.11)	-.504*** (-11.46)
CUMDISST*CAPUTIL			-3.65×10^{7} (-1.77)	-9.69×10^{7}*** (-4.89)
CUMDISNST*CAPUTIL			-2.70×10^{7} (-1.35)	-1.20×10^{8}*** (-7.59)
$R^{2(a)}$	.85	.81	.85	.82

t-statistics are in parentheses

***Significant at the.01 level.

**Significant at the .05 level.

(a) The R^2 statistic for the error components model is computed as 1-SSE/SST. See Kmenta (1971).