RAND Journal of Economics
Vol. 36, No. 3, Autumn 2005
pp. 628–644

Regulatory opportunism and investment behavior: evidence from the U.S. electric utility industry

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Large sunk costs and incomplete regulatory contracts in public utilities create the possibility of opportunistic behavior by either regulators or regulated firms. We present an empirical methodology for identifying opportunism within a regulated setting, and apply it to the large-scale cost disallowances levied by state regulators on electric utilities during the 1980s. Examining the investment propensity of all firms—both those that faced cost disallowances and those that did not—within particular regulatory jurisdictions, we find little evidence that cost disallowances were opportunistic. Instead, regulators appear to have been largely driven by the desire to punish specific poorly managed utilities.

1. Introduction

■ Major cost disallowances by regulators of public utility investments have always been a possibility. In the mid-1980s, however, this possibility came to life in the form of roughly $19 billion of disallowances of electric power plant investments that would otherwise have become part of the utilities' rate bases. In response, a number of industry members and observers alleged that the implicit "regulatory contract" between regulators and regulated firms was violated, with regulators opportunistically reneging on their end of the deal after fundamental demand and supply conditions had shifted.[1]

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We would like to thank David Mayes, Robert Book, and Sean Montgomery for excellent research assistance, Elsie Bess at the Energy Information Administration for help in gathering the data, Bill Bumpers for helpful discussions in the formulation of this article, and Michael Banta, Steven C. Peck, Rob Porter, two anonymous referees, and various seminar participants. We would also like to acknowledge the Kelley School of Business, the McDonough School of Business, the George Stigler Center at the University of Chicago, and the Zentrum für Europäische Integrationsforschung at the Universität Bonn for financial support for this research.

[1] For example, Pierce (1991, p. 8) argued that "Opportunistic behavior by state regulators has so distorted utility decisions to invest in new plants that the United States is virtually certain to face some combination of blackouts, brownouts, and unnecessarily high electricity rates sometime in the 1990s" Similarly, Joskow (1989, p. 161) stated 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), Kahn (1985), Leonard, Kalt, and Lee (1987), and Kolbe and Tye (1991).

Some support for the industry perspective may be inferred from a small theoretical literature including articles by Lyon (1991), Gal-Or and Spiro (1992), Gilbert and Newbery (1994), and Lyon and Li (2004). Although these articles adopt different modelling approaches, all suggest that a sudden conversion by regulators to hindsight reviews will reduce the investment propensities of regulated firms.[2] However, this literature also shows that the ability to disallow excessive costs can help regulators achieve more efficient levels of investment by curbing the incentives for overinvestment. Thus, large disallowances per se are not evidence that the regulatory contract has broken down, and may reflect reasonable punishment for managerial excess.[3] Whether the disallowances of the 1980s represent regulatory opportunism or punishment of utility excesses is, however, ultimately an empirical question.

In this article we distinguish between these alternative interpretations by focusing on how the investment behavior of electric utilities changed in the wake of regulatory cost disallowances. Specifically, we model electric utility investment decisions for the 1970–1991 period, prior to the phase of industry restructuring ushered in by the Energy Policy Act of 1992. Using a panel dataset involving 156 electric utilities, we first examine the general investment tendencies of these firms, and then turn to a regression-based model of utility investment. By examining investment responses to regulatory disallowances, we are able to distinguish between a "violation of the regulatory contract" proposition that has been advanced by the industry and a competing "bad management" proposition that has been alternatively suggested.

We argue that if a state utility commission opportunistically violates the implicit regulatory contract by disallowing specific utilities' investments, then other firms that are subject to the same regulatory jurisdiction should react by reducing their investment. That is, the other firms will reveal by their own reduced investment that they believe the implicit regulatory contract has been violated. In contrast, if a commission imposes cost disallowances as punishment for specific managerial excesses, then the disallowed firm should reduce its investment, but other firms have no reason to change their investment behavior.

Our results indicate that a utility that suffers a regulatory cost disallowance does subsequently invest less. Other utilities in the same state, however, show no significant reduction in investment, indicating that disallowances were interpreted as punishment of company-specific managerial excess rather than an abrogation of the regulatory contract. Interesting subtleties emerge when we control for the type of generating units firms had under construction. In particular, firms that either had no ownership stake in a nuclear plant under construction or had an ownership stake but no responsibility for operating such a facility did not alter their investment behavior in response to adverse regulatory actions taken against other regulated firms in the same jurisdiction. Only in one situation do regulatory cost disallowances appear to have had "reputational spillovers": utilities planning to serve as operators of nuclear power plants under construction reacted negatively when other utilities within the same state were subjected to a cost disallowance. The isolated nature and limited robustness of the spillover effects is striking, and suggests that regulatory opportunism was limited at most to operators of nuclear units. Indeed, the lack of reaction by nonoperator owners of nuclear plants under construction is consistent with the view that regulators punished managerial errors and not nuclear technology more generally.

The remainder of the article is organized as follows. In Section 2 we provide a conceptual framework by explaining the nature of regulatory cost disallowances, and we lay out alternative explanations for regulated firm behavior in the wake of such disallowances. In Section 3 we present

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[2] Teisberg (1993) shows that when firms are uncertain about future regulatory behavior, hindsight review could in principle *increase* utility investment in the short run if firms rush to complete building programs before regulators become even harsher.

[3] See Blank and Pomerance (1992). In addition, Zimmerman (1988) argues that regulatory treatment of cancelled nuclear power plants was 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 prior episode of partial cost disallowances suggests at least the possibility that incumbent electric utilities would have already accounted for this potential and that, accordingly, the realization of such disallowances in the 1980s would have no effect on investment propensities.

our empirical specification of electric utility investment decisions for the period 1970–1991. We first examine the investment tendencies of these firms and then specify and estimate a model of utility investment. Section 4 reports our empirical results, and Section 5 concludes.

2. Conceptual framework

■ The traditional regulatory process determines utility revenues in a series of three steps. First, regulators determine which operating costs are to be recovered in rates. 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" (nondepreciated 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.[4]

Cost disallowances have typically occurred within the context of establishing the utility's rate base. The bulk of these disallowances have been categorized under the heading of management imprudence, but major disallowances have also occurred 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). Regulators have discretion over the criteria to which they will hold a given investment, a clear example of the incompleteness of the "regulatory contract."

In practice, it is the application of the retrospective criteria that has been most controversial. Thus, it is striking that both Gal-Or and Spiro (1992) and Lyon (1991)—who study the used-and-useful test and the economic-value test, respectively—find that a shift in regulatory regime that suddenly allowed the use of cost disallowances would be associated with reduced investment by utilities, but would not generally lead to inefficient underinvestment.[5] However, Gilbert and Newbery (1994) find that underinvestment can emerge in a supergame with random demand. They show that to deter investment in excess capacity, the regulator must cut the firm's rate of return in low-demand situations, but if the disallowance goes too far, the firm retaliates 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. Lyon and Li (2004) present a dynamic signalling model in which a single regulator oversees two different firms, and show that an opportunistic disallowance produces a reputational spillover that induces other firms in the same jurisdiction to underinvest.

We are particularly interested in how firms update their beliefs about their state regulatory commission after the commission announces a disallowance. A firm's beliefs, of course, are unobservable. Consequently, we focus on observed investment behavior, because the propensity to invest should vary directly with the firm's belief that the regulator will treat investments fairly and not opportunistically. We distinguish three hypotheses about the effects of regulation on investment, referring to them as "regulatory opportunism," "bad luck," and "bad management."

"Regulatory opportunism" posits that the emergence of large-scale cost disallowances in the 1980s reflected a structural shift, with regulators becoming systematically more stringent, and opportunistic, in evaluating the prudence of utility investments. Under regulatory opportunism, cost disallowances should reduce investment by other nondisallowed utilities within the same regulatory jurisdiction.

"Bad luck" holds that firms knew cost disallowances were a possibility in unfavorable states of the world and made rational investments in the face of this possibility. A cost disallowance

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

[5] Lyon (1995) shows that if the firm chooses between a safe project and a risky project with lower expected costs—as might be expected for process innovations—then underinvestment may occur.

provides no new information but reflects a state of the world with unexpectedly low demand or high costs. As a result, a cost disallowance should have no impact on the future investment propensity of either the firm that was disallowed or any other firm.

"Bad management" holds that some firms are better managed than others and that cost disallowances are used by regulators to punish managerial failures to control construction costs, develop accurate demand forecasts, adjust investment as forecasts of future demand growth are curtailed, or bargain aggressively for critical inputs to the production process. A disallowance of this sort will lead the firm that suffers the disallowance to scale back its subsequent investments, but other firms under the same regulatory jurisdiction should not change their propensity to invest.

The determinants of investment are multifaceted, so to isolate the effects of disallowances, we must account for other influences on investment.[6] First, investment increases with the size of the current capital stock to compensate for capital depreciation. Second, investment decreases with megawatt capacity, controlling for current and forecast future demand. Third, investment should increase with the level of current utility sales and with forecast levels of demand growth. Fourth, investment should decrease with the supply of nonutility power, which substitutes for utility-produced power, as explained in more detail in the Section 3. Fifth, investment should decrease with the cost of capital. Sixth, to the extent firms rely on internal sources of funds for investment, investment should increase with the firm's earned rate of return. Seventh, investment should increase when investment analysts rate the regulatory climate, e.g. the fairness and predictability of regulators, in a given state more highly.

3. The empirical determinants of electric utility investment

■ **Background and data.** We assembled investment data from 1970 to 1991 on the entire set of 156 investor-owned electric utilities (IOUs) for which continuous investment data were reported by the U.S. Department of Energy, Electric Power Division (EPD) in its *Financial Statistics of Selected Electric Utilities*.[7] We eliminated 16 firms with no generating capacity (which we expect to have different investment patterns) and another 8 firms for which data appeared internally inconsistent. The remaining 132 firms in our sample are drawn from the 48 contiguous states and represent 89% of 1991 total sales to final customers by IOUs in the United States and 87% of IOU sales for resale. We focus on investment in the form of additions to electric utility plant.[8]

Figure 1 graphs aggregate inflation-adjusted electric utility investment over time. Two features of Figure 1 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 high degree of capital intensity is 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. (See ORNL, 1987.) Second, investment peaked in the early 1980s and fell between 1985 and 1991.

Figure 2 distinguishes firms that incurred regulatory cost disallowances at any point in the sample period from those that did not. Real investment by electric utilities that were not penalized with regulatory cost disallowances peaked in 1973 and declined more or less continuously throughout the subsequent period. In contrast, firms that suffered a cost disallowance increased investment from 1975 through 1984, after which investment spending declined sharply.

It was not until the mid-1980s that significant dollar volumes of cost disallowances began

[6] The ability to do so follows directly from both the theoretical literature, including Lyon (1991), Gal-Or and Spiro (1992), Salant and Woroch (1992), Teisberg (1993), Gilbert and Newbery (1994), and the empirical literature on investment and financing constraints, including Jorgensen (1971), Jorgenson and Handel (1971), Peck (1974), Oliner and Rudebusch (1992), Fazzari and Petersen (1993), and Kaplan and Zingales (1997).

[7] Thus, we limit ourselves to the period prior to the passage of the Energy Policy Act of 1992, which ushered in an era of restructuring and greater competition in wholesale markets.

[8] This variable covers all electric plant owned or purchased by the utility, including intangible plant, production plant, transmission plant, distribution plant, and general plant. Note that it is *not* a measure of regulatory rate base treatment of utility plant, but simply measures additions to utility plant as made by the utility company.

FIGURE 1

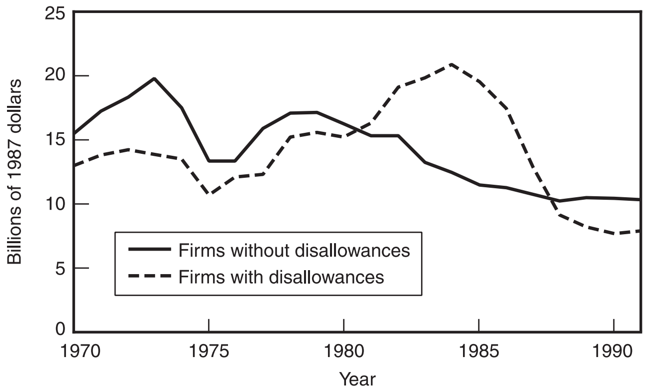
REAL INVESTMENT BY ELECTRIC UTILITIES, 1970–1991, ALL FIRMS

to occur in the electric utility industry.[9] Typical disallowances during the mid-1980s amounted to hundreds of millions of dollars, and in two cases (the Nine Mile Point 2 unit in New York and the Diablo Canyon plant in California) regulatory cost disallowances were $2 billion or greater.[10] Figure 3 provides the total nominal 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 disallowances on 37 different generating units were observed in the sample period, with a total dollar volume of disallowance of over $19 billion.[11]

Aside from regulatory cost disallowances, the major policy change during the sample period stemmed from the passage of the Public Utilities Regulatory Policies Act (PURPA) in 1978. The purpose of PURPA, in part, was to encourage the efficient use of fossil fuels through the growth of

FIGURE 2

REAL INVESTMENT BY ELECTRIC UTILITIES, 1970–1991, BY FIRM TYPE



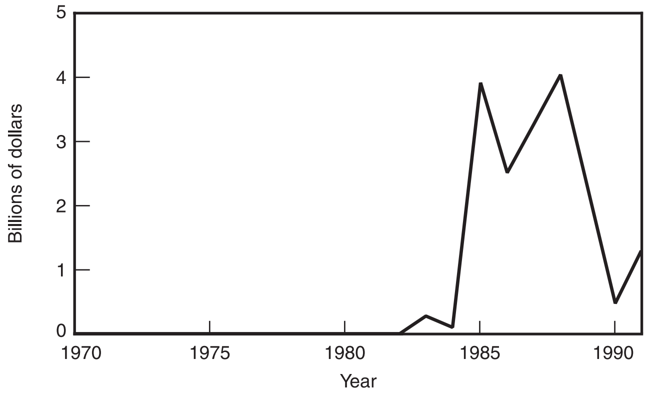
[9] See Kahn (1988) for a thorough historical discussion of the legal and economic issues surrounding regulatory cost disallowances.

[10] As noted in Section 2, disallowances have taken several forms. A review of the rationales provided for disallowances indicates that regulators frequently relied upon a combination of the "economic value," "used and useful," and "prudent investment" rationales when disallowing costs. Thus, while it would be interesting to know whether different types of disallowances produced different investment responses, the limited number of distinct disallowances within each category limits our ability to further disaggregate the impact of cost disallowances on investment behavior.

[11] Our data on cost disallowances are drawn from four sources. A complete description of the process by which we assembled these data, along with a complete list of disallowances on a generating unit basis, is given in the Appendix.

FIGURE 3

DOLLAR VALUES OF REGULATORY DISALLOWANCES, 1970–1991



co-generated power and the use of renewable resources. A key feature of PURPA is a requirement that electric utilities interconnect with and purchase power from any "qualifying facility" (QF).[12] 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 their electricity. Because the magnitude of "avoided costs" was initially set by fiat at what many consider to be relatively lucrative rates,[13] rather than through a competitive bidding process, and because QFs are not cost-of-service regulated, the amount of investment by nonutilities in electricity-producing cogeneration and small power-producing facilities grew rapidly during the latter part of the 1980s.

To account for other factors that may influence investment, we gathered a variety of additional data. For instance, we account for firm-level capacity in the empirical analysis.[14] We also assembled data that identify, for every year of the sample period, all utilities that held an ownership stake in a nuclear plant that was under construction in that year. These data came from the Nuclear Regulatory Commission's *Information Digest, 1996 Edition*, which lists each commercial nuclear power plant in the United States along with the dates that its construction permit and operating license were issued. We considered a given plant to be under construction during the period between the issuance of the construction permit and the operating license. By matching the nuclear plant construction data with plant-level ownership data from the EPD, we were able to identify every utility that had an ownership stake in a nuclear plant under construction for every year of the sample period.

We also gathered data reflecting the financial and regulatory situation in which each utility operated. For instance, data on the annual earned rate-of-return on common equity for each firm were assembled. To the extent that firms rely on internally generated funds to finance investment, there should be a positive relationship between rate of return and investment. In addition, one might expect that investment would depend upon prevailing perceptions of the regulatory climate in each state. To reflect this factor, we gathered the Duff and Phelps investment analysts' ratings of state utility commissions, which were available from 1972 to 1991. Commissions are rated

[12] PURPA defines two types of qualifying facilities: (1) co-generators 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 qualifying facilities account for roughly three-quarters of all nonutility power generation. For details, see EIA (1993).

[13] See, for example, Joskow (1989).

[14] Unfortunately, the Electric Power Division does not compile historical time series of firm-specific capacity data. Thus, it was necessary to construct the series for each firm using plant-level data from the 22 individual years of EPD data.

on a scale of 1 to 6, with 1 the highest rating. To the extent that these evaluations were viewed as informative by investors, we expect investment to be negatively correlated with the Duff and Phelps rating.[15]

□ **The empirical model and estimation issues.** Our baseline empirical model embodies the hypotheses outlined in Section 2. Because of the importance of state-level regulation in this industry, we model investment as a function of firm-specific variables (indicated by **X**) and state-specific variables (indicated by **Y**), plus interaction terms.[16] Thus, we specify investment **(I)** by utility i in state j at time t as

$$\mathbf{I}_{i,j,t} = \beta_0 + \beta_1 \mathbf{X}_{i,t} + \beta_2 Y_{j,t} + \beta_3 \mathbf{X}_{i,t} \mathbf{Y}_{j,t} + \varepsilon_{it}. \quad (1)$$

Table 1 lists the model's variables along with their descriptive statistics. The lagged value of the *Capital Stock* is included to account for replacement investment, and we expect that its coefficient will be positive.[17] The lagged level of *Capacity* and current sales (both *Sales to Consumers* and *Sales for Resale*) are included to account for the proximity of the firm to its capacity constraint; we expect the demand coefficients to be positive and the capacity coefficient negative.[18] Consistent with accelerator models of investment, we include *Demand Growth*, the realized value of end-user retail electricity sales growth over the subsequent two years,[19] to account for the level of anticipated demand, and we expect a positive coefficient.[20] Next, we include the amount of electric power supplied by nonutility generators, *Purchases from NUGs*, 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 *Purchases from NUGs* will negatively influence the investment propensities of incumbent utilities. Additionally, we include a measure of the amount of purchased power from other utilities, *Purchases from Utilities*. To the extent that purchased power is more expensive than self-generated power, higher values of such purchases are likely to indicate capacity constraints that are unaccounted for in our other firm-level measures of capacity utilization. Accordingly, we expect higher values of *Purchases from Utilities* to increase the investment propensity of electric utilities.[21] Consistent with standard

[15] We experimented with both contemporaneous and lagged versions of both variables discussed in this paragraph. Overall, the results did not change much, with the financial variables tending to be of the expected sign but only marginally significant. We did find that including both contemporaneous and lagged variables diluted the statistical significance of the variables. Since it was not clear to us that there was a strong theoretical rationale for either contemporaneous or lagged financial performance, we opted to keep only the contemporaneous variables, since they had greater explanatory power.

[16] Our measures of real investment and of the firm's capital stock are deflated using the Handy-Whitman Index of electric utility plant construction costs. This is a commonly used inflation index tailored to the specific inputs used in electric utility construction. It is produced by the engineering-architect consulting firm of Whitman, Requardt and Associates, based in Baltimore, Maryland.

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

[18] We also performed a set of estimations with capacity utilization as a right-hand-side variable, where capacity utilization is defined as the ratio of electricity generation to capacity. When capacity utilization and lagged capacity utilization were added to the other set of regressors, their coefficients were consistently statistically insignificant. When lagged capacity utilization was used in place of lagged capacity, sales to consumers, and sales for resale, we found lagged capacity utilization was consistently positive and significant. However, other coefficients and their significance were basically unchanged from the specifications we report in this article.

[19] Our approach here is akin to Oliner and Rudebusch (1992), who include current sales in an empirical model of investment. Given the longer planning horizon for electric utilities, we include a two-year window of future sales growth. While we experimented with longer windows, they did not significantly alter the explanatory power of the regression.

[20] Many electric utilities repeatedly overestimated demand growth during the 1970s and 1980s; see Nelson and Peck (1985) for an early discussion of this problem. In part, these underestimates of long-term demand elasticity resulted from failures to recognize that higher electricity prices spurred customer investments in energy-efficient capital equipment. While it would have been interesting to use firm-specific year-to-year forecasts as well as realized demand growth in the empirical model, such forecasts are not publicly available for firms in the electric utility industry.

[21] Both *Purchases from NUGs* and *Purchases from Utilities* report the net value of purchases and exchanges of power from each of these sources. Because exchanges can be either positive or negative, it is possible for these two variables to take on negative values, as is shown in Table 1.

TABLE 1 Descriptive Statistics

Variable	Description	Mean	Standard Deviation	Minimum	Maximum	Source
Real Investment	Real investment (millions 1987 $) by utility i in year t measured as additions to utility plant, deflated using the Handy-Whitman index of utility plant construction costs	212.9412	286.9136	−22.7852	2088.869	1, 2
Real Capital Stock	Real (millions 1987 $) capital stock measured as net electric utility plant in year t. Deflated using Handy-Whitman index	1807.66	2287.87	2.7511	17787.09	1, 2
Capacity	Maximum generating capacity in thousands of MW	3.412	3.823	.0011	24.900	3
Sales to Consumers	Sales to ultimate consumers, in millions of kwh	10.5	12.4	0	70.2	1
Sales for Resale	Sales to other utilities for resale, in millions of kwh	1.883	2.831	0	22.4	1
Demand Growth	Demand forecast computed using the realized value of sales growth in percent over years t to $t+2$.	7.270	18.406	−75.96	443.48	1
Purchases from NUGs	Thousands of net mwh purchased from and exchanged with nonutility generators	72.92835	751.6961	−53.882	19,400	1
Purchases from Utilities	Thousands of net mwh purchased from and exchanged with other utilities	1664.517	3688.999	−10,100	115,000	1
Real Interest Rate	The financial cost of capital, as proxied by the prime lending rate	4.339	3.135	−.880	9.745	4
Nuke Operator	Dummy variable = 1 if utility was building in year t a nuclear plant that it would eventually operate	.156	.363	.00	1	6
Nuke Owner	Dummy variable = 1 in year t if utility held ownership share in a nuclear plant under construction that it would not operate	.188	.391	.00	1	6
Earned Rate of Return	Rate of return on common equity	11.496	44.648	−2335.55	139.00	1
Commission Rating	Duff and Phelps rating of investment environment of each state commission	3.818	1.321	1	6	7
Disallowance Dummy	Dummy variable =1 if utility has been subject to a regulatory disallowance prior to year t	.049	.216	.00	1	5
Disallowance Dummy within State	Dummy variable = 1 if a utility in the same state has been subject to a disallowance prior to year t.	.098	.298	.00	1	5
Cumulative Disallowance	Cumulative real dollars (millions 1987 $) disallowed from utility i	20.341	138.244	.00	1946.095	5
Cumulative Disallowance within State	Cumulative real dollars (millions 1987 $) disallowed other utilities in the same state	86.817	374.365	.00	3536	5

Sources: 1: EIA, *Financial Statistics of Selected Electric Utilities*; 2: U.S. Department of Commerce, *Current Construction Reports*; 3: EIA, Form 860; 4: U.S. Department of Commerce, *Survey of Current Business*; 5: Oak Ridge National Laboratory (1987), DOE (1989), and LaBoeuf et al. (1991); 6: NRC (1996); 7: Duff and Phelps. Note that the Duff and Phelps ratings changed from a 1 to 6 scale (with 1 as high) to a 1 to 5 scale between 1989 and 1990. For the years 1990 and 1991, we employed a transformation that expanded the "step" between ratings from 1 to 1.25.

investment theory, we include the *Real Interest Rate* as an explanatory variable.[22] We also include the *Earned Rate of Return* on common equity to reflect the possibility of a financing hierarchy in which internal sources of capital translate more readily into increased investment. Finally, to capture the possibility that the availability of external sources of funds was influenced by analysts' recommendations, we include the Duff and Phelps ratings of state commissions (*Commission Rating*), expecting a negative relationship between the rating and a firm's propensity to invest.[23]

[22] The *Real Interest Rate* variable does not vary across firms but only across time.

[23] Note that all states require prior regulatory approval of significant investments. While there may be some subtle differences in the stringency of these approval processes, we are unable to capture any meaningful interstate variation in *ex ante* state regulatory approval processes as a relevant determinant of investment.

Several variables are included in the specification of equation (1) to account for the nature of the regulatory cost disallowances that were imposed on some electric utilities in our sample.[25] First, we include two alternative measures of regulatory cost disallowances for specific firms. *Cumulative Disallowance* is the cumulative real dollar value at time t of the disallowances faced by firm i operating in state j.[25] As an alternative specification that does not require the ability to accurately measure the dollar magnitude of the disallowance, we consider the indicator variable *Disallowance Dummy*, indicating whether utility i operating in state j has been subjected to a regulatory cost disallowance in any year prior to time t. Under either the "regulatory opportunism" or "bad management" hypotheses, the effect of regulatory cost disallowances should be a reduction in the observed propensity to invest by the firm that is the target of the cost disallowance. Under the "bad luck" hypothesis, cost disallowances are essentially viewed simply as bad luck with no subsequent change in the firm's investment propensities.

In addition to measures of own-firm disallowances, we control for the presence of cost disallowances imposed on other firms by a particular state commission. Specifically, for any given firm i operating in state j, *Cumulative Disallowance within State* represents the cumulative dollar value of regulatory cost disallowances up to time t faced by utilities $k \neq i$ that operate in the same regulatory jurisdiction as i. Alternatively, we specify *Disallowance Dummy within State* to take on a value of one if any utility $k \neq i$ operating in state j has previously been subjected to a regulatory cost disallowance. The examination of investment behavior of individual firms in response to cost disallowances of other firms in the same state allows us to distinguish between the "regulatory opportunism" and the "bad management" hypotheses. In particular, if the disallowance of firm k in state j signals an opportunistic shift in regulatory policy, then other firms that are subject to the same regulatory oversight (such as firm i) will be observed to reduce their investment propensities. Alternatively, if the "bad management" hypothesis is correct, then cost disallowances of firms $k \neq i$ should have no measurable effect on firm i's propensity to invest. This, then, constitutes our base model to be estimated.

Beyond our base model, it is possible that investment behavior for nuclear plants has been significantly different from that for other technologies. Accordingly, in a more technology-specific set of regressions we identify those utilities that were in the process of building a nuclear power plant in any given year. We allow for both the possibility that these firms had overall investment propensities different from those of other firms, and the possibility that the "spillover" effects of third-party disallowances are different for utilities that are building nuclear power plants than for utilities not involved in nuclear plant construction. Thus, we include dummy variables that indicate whether a firm was involved in the construction of a nuclear power plant during each sample year, either as the plant operator (*Nuke Operator*) or as an owner (*Nuke Owner*). Spillover effects are discussed below.

A number of variables interacting firm-specific and state-specific effects are also included in the model. In particular, we allow for differential spillover effects from disallowances within a given state, depending on whether or not a firm was involved in the construction of a nuclear plant. Because we consider two different measures of disallowances, we include two sets of interaction variables. Using the dummy variables, we include the interaction of *Disallowance Dummy within State* and *Nuke Operator*, and the interaction of *Disallowance Dummy within State* and *Nuke Owner*. Similarly, for the cumulative disallowance measures we include the interaction of *Cumulative Disallowance within State* and *Nuke Operator*, and the interaction of *Cumulative Disallowance within State* and *Nuke Owner*. If these variables have significant effects, then this would indicate that utilities believed cost disallowances signalled an opportunistic shift

[25] The exact nature of the signal through which regulated firms interpret regulatory behavior such as cost disallowances is not, to this point, answered by economic theory. Accordingly, we explored several alternative measures of cost disallowances. For instance, in addition to those reported here, we also performed a set of estimations using a cumulative record of the number of independent cost disallowances suffered by a single firm, as well as the total across all firms within a state. These estimations provided insights similar to those reported here, although spillover effects were less significant. We discuss the results from this set of estimations at appropriate junctures below.

[25] Because disallowances are deflated to 1987 dollars, the impact of a disallowance on future investment subsides over time.

in regulatory policy toward nuclear plants, separate from any shift that may have been happening for utilities constructing new plants using other technologies.

Equation (1) involves both cross-section and time-series data and, as indicated by the results of a Lagrange multiplier test, includes firm effects. The question remains as to whether a random-error specification or fixed-effects specification is more appropriate. Thus, we performed the specification test proposed by Hausman (1978). The results point toward the fixed-effects model. In addition to firm fixed effects, we include a full set of year dummies to account for shocks such as business cycle effects, oil price shocks, and changes in natural gas legislation.[26]

There were numerous economic and political shocks during our sample period, and shocks to investment in a given year may be serially correlated. A standard test of first-order serial correlation could not be rejected, though we found no evidence of higher-order serial correlation. A greater concern is the fact that investment in period t increases the capital stock in period $t + 1$, and a portion of investment in period t goes to increase generation capacity in future periods. Hence, even if the error terms are not serially correlated, the lagged capital stock and lagged capacity variables may be correlated with the contemporaneous error terms. This may be a modest problem in our setting, since annual investment is a fraction of the existing capital stock. Nevertheless, to control for this possibility, we estimated a variant of equation (1) using both a standard Cochrane-Orcutt (1949) transformation to allow for first-order autocorrelation of the error terms and also a technique suggested by Arellano and Bond (1991) using a two-step generalized method of moments (GMM) estimator.[27]

4. Empirical results

■ We present our empirical results first at a general level that is independent of the participation by firms in specific (namely, nuclear) technologies. We then turn to a more detailed analysis that identifies firms with nuclear construction programs.

□ **Aggregate results without nuclear plant construction profiles.** The estimations are reported in Table 2. Model 1 uses dummy variables that account for whether or not a disallowance has occurred. Model 2 makes use of cumulative dollar values of disallowances, and Model 3 includes both sets of variables. Overall, the estimation results are encouraging. Both the model F-statistic and the R^2 for the within estimator are solid.

The individual parameter values and their statistical significance provide specific insight into the particular determinants of electric utility investment propensities. As hypothesized, the levels of lagged capital stock, lagged capacity, and current demand are significant determinants of electric utility investment, with the anticipated signs. Not surprisingly—given regulators' interest in protecting residential customers—*Sales to Consumers* is a much more important driver of investment than is *Sales for Resale*. As expected, we find that the supply of nonutility power (*Purchases from NUGs*) 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 estimates also indicate that greater purchases from other (non-NUG) utilities heighten the firm's propensity to invest in new plant and equipment. This suggests that utilities view short-term purchases from other utilities as indicative of capacity shortfalls on their own systems, and thus as indicative of a need to build additional capacity. The level of future demand growth, the earned rate of return, Duff and Phelps ratings, and the real interest rate have statistically insignificant coefficients.

As discussed in Section 2, the model allows us to discriminate between three hypotheses: (1) regulatory opportunism, (2) bad luck on the part of some utilities, and (3) bad management on the part of some utilities. We begin this inquiry by noting that utilities that have been subject

[26] We also performed a series of Chow tests (see Greene, 2000, for details) for the possibility of structural changes that may have occurred after the passage of PURPA in 1978, after the Three Mile Island nuclear incident in 1979, and two years prior to the passage of the Energy Policy Act of 1992. None of these specifications had any notable effect on the sign, magnitude, or statistical significance of our disallowance estimates, so we do not report them here.

[27] In light of the inconsequential differences that emerge from these alternative estimation procedures, we report only the former results.

TABLE 2 Real Investment in the Electric Utility Industry

Variable	Model 1	Model 2	Model 3
Real Capital Stock Lagged	.0120**	.0162***	.0175***
	(2.29)	(3.11)	(3.34)
Capacity Lagged	−67.3186***	−65.0557***	−64.3412***
	(−11.34)	(−11.04)	(−10.93)
Sales to Consumers	8.5618***	9.0271***	9.0655***
	(4.37)	(4.68)	(4.70)
Sales for Resale	−.9033	−.9212	−.8578
	(−.48)	(−.50)	(−.46)
Purchases from NUGs	−10.2232***	−7.7645**	−7.5377**
	(−2.85)	(−2.18)	(−2.12)
Purchases from Utilities	1.5335**	1.4890**	1.4782**
	(2.37)	(2.31)	(2.30)
Real Interest Rate	1.4387	1.2753	1.2263
	(.95)	(.85)	(.82)
Demand Growth	.0119	.0124	.0114
	(.73)	(.77)	(.71)
Earned Rate of Return	.0418	.0389	.0400
	(1.11)	(1.04)	(1.07)
Commission Rating	5.1426	4.0710	4.3313
	(1.57)	(1.26)	(1.34)
Disallowance Dummy	−48.2815**		−34.1685**
	(−3.22)		(−2.28)
Disallowance Dummy within State	3.4157		5.3401
	(.30)		(.46)
Cumulative Disallowance		−.1523***	−.1431***
		(−6.72)	(−6.22)
Cumulative Disallowance Within State		−.0065	−.0050
		(−.68)	(−.51)
Number of observations	2,417	2,417	2,417
R^2 within	.1429	.1572	.1598
F-test	12.55	14.05	13.41

*** Significant at the .01 level.
** Significant at the .05 level.
* Significant at the .10 level.
t-statistics are in parentheses.

to regulatory cost disallowances have markedly reduced propensities to engage in investment. Model 1 shows that a utility that has been disallowed subsequently reduces annual investment by about $48.3 million. Alternatively, Model 2 indicates that every million dollars disallowed led the affected firm to reduce annual investment by roughly $152,000. Since the 37 plants in our sample that were disallowed suffered an average disallowance of nearly $520 million, Model 2 suggests a subsequent investment reduction of about $79 million for utilities that were disallowed. Model 3, which includes both sets of disallowance variables, shows both of the own-firm effects to be negative and highly significant. These results provide strong evidence that the disallowances were not simply the result of "bad luck," e.g., unfortunate draws from the distribution of possible future demand levels. As discussed earlier, the "bad luck" hypothesis implies no shift in investment propensity after a disallowance: instead, utilities should continue with their existing investment practices, recognizing that demand and cost uncertainty means that some negative outcomes must be anticipated. This is clearly not observed in the data.[28]

[28] It is possible we would have obtained some support for the "bad luck" hypothesis if we had firm-specific year-to-year forecasts of future demand, and firms differed significantly in the quality of their demand forecasts. That is, to

Next, we turn to the variables that allow us to differentiate between the "regulatory opportunism" and the "bad management" hypotheses. Specifically, the spillover variables within the state capture whether a regulatory disallowance for firm i in state j had spillover effects on firms $k \neq i$ in the same state. Model 1 indicates a small positive spillover to other firms, but the coefficient is not statistically significant. Model 2, on the other hand, shows a small negative spillover, but it is again insignificant. Model 3, which includes both spillover measures, finds both to be small and insignificant. These results indicate that firms showed little fear of a regulatory regime shift associated with cost disallowances of other firms within the state, as they did not significantly adjust their investment propensities in the wake of disallowances. This indicates that post-disallowance investment behavior cannot be simply attributed to a regulatory regime shift or a sudden abandonment of an implied regulatory contract.

□ **Results accounting for nuclear plant construction profile.** In light of the unique controversies associated with nuclear power, it is of interest to know whether the investment behavior of firms constructing nuclear power plants differs systematically from that of other firms. In this regard, it is useful to distinguish the 18 states that imposed at least one disallowance during the sample period from the 32 that imposed no disallowances. Doing so, we find that 79 of our 132 firms were located in the 18 states that made one or more disallowances during our sample period. Of these firms, 32 had no part in nuclear construction during the sample period. Twenty firms were operators of nuclear plants built during the sample period, and 35 were partial owners but not operators of nuclear plants during this period.[29] Of the 53 firms that were located in the 32 states that made no disallowances during the sample period, 37 had no part in nuclear construction during the sample period, while 13 firms were nuclear plant operators and 4 held ownership stakes in plants they did not plan to operate.

The fraction of firms electing to operate nuclear plants is almost exactly the same in states with disallowances (25.3%) and states without them (24.5%). Clearly, not all nuclear plant operators had costs disallowed. However, one striking difference between the two groups of states is that states with disallowances had a large number of companies that held ownership stakes in but did not plan to operate nuclear plants, while in states with no disallowances there were few nonoperator owners. This suggests that nuclear plant operators with large ownership stakes may have exercised more diligent cost control than operators for whom cost overruns would be spread over a number of co-owners.[30] Nevertheless, while the correlation between disallowances and potential agency problems is intriguing, exploring it in detail is beyond the scope of this article.

The regressions focusing on nuclear technology are reported in Table 3. In light of the similarity of the overall results to those reported in Table 2, we discuss only the results that provide additional insights or differences. Table 3 shows that utilities building nuclear plants they intend to operate once construction is completed (*Nuke Operators*) invest between \$73.2 million (Model 2) and \$87.1 million (Model 1) per year more than do other utilities. Utilities with an ownership stake in a nuclear plant under construction (*Nuke Owners*), but who will not be the plant operator, invest more than firms with no stake in a nuclear plant (between \$34 million and \$41.9 million, depending on the model used), but less than nuclear plant operators.

Table 3 provides strong evidence that firms that experience a cost disallowance subsequently reduce their investment significantly. In Model 1, the coefficient on the disallowance dummy is

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the extent regulators engaged in "efficient" disallowances rather than opportunistic ones, we would expect a positive correlation between overly optimistic demand forecasts and subsequent disallowances, so disallowances might be simply reflecting unexpectedly low demand growth. Nevertheless, given the strong statistical significance of our results, we would be surprised if the "bad management" hypothesis could be rejected, even if we had demand forecast data.

[29] Eight firms were operators of one or more nuclear plants and also held ownership stakes in other nuclear plants.

[30] To explore this idea, we created a Herfindahl-type measure of the concentration of ownership for each nuclear plant and then examined whether the average value of this measure changed over time. Between 1966 and 1977, the interval when the vast majority of nuclear plants began construction, the average concentration index of ownership fell from .938 to .510. At the same time, the fraction of plants that suffered disallowances rose from zero to 75%. The correlation between a binary variable for disallowance and ownership concentration on a plant-level basis is −.37, consistent with the "bad management" notion that agency problems were related to disallowances.

TABLE 3 Real Investment in the Electric Utility Industry: Nuclear Operator and Nuclear Ownership Effects

	Model 1	Model 2	Model 3
Real Capital Stock Lagged	.0153***	.0184***	.0207***
	(2.94)	(3.58)	(4.00)
Capacity Lagged	−55.8751***	−55.3503***	−53.9708***
	(−9.15)	(−9.11)	(−8.91)
Sales to Consumers	9.3253***	9.4045***	9.7088***
	(4.87)	(4.96)	(5.14)
Sales for Resale	−.7211	−.5864	−.6429
	(−.39)	(−.32)	(−.35)
Purchases from NUGs	−8.7796***	−6.6787*	−6.5791*
	(−2.52)	(−1.91)	(−1.89)
Purchases from Utilities	1.6261***	1.5730***	1.5825***
	(2.52)	(2.44)	(2.46)
Real Interest Rate	7.3742***	7.2387***	7.1111***
	(5.51)	(5.47)	(5.40)
Demand Growth	.0115	.0107	.0109
	(.71)	(.67)	(.68)
Earned Rate of Return	.0432	.0400	.0402
	(1.15)	(1.08)	(1.08)
Commission Rating	4.7882	3.8567	3.9099
	(1.48)	(1.20)	(1.22)
Nuke Operator	87.1213***	73.1698***	79.1854***
	(5.78)	(4.98)	(5.28)
Nuke Owner	34.0467***	41.9107***	35.2473***
	(2.55)	(3.22)	(2.64)
Disallowance Dummy	−35.9814**		−20.9260
	(−2.39)		(−1.37)
Disallowance Dummy within State	5.5331		3.6855
	(.46)		(.30)
Disallow Dummy ∗ Nuke Operator	−54.3127**		−62.4825**
	(−2.19)		(−2.19)
Disallow Dummy ∗ Nuke Owner	9.4948		34.2285
	(.43)		(1.38)
Cumulative Disallowance		−.1383***	−.1365***
		(−6.16)	(5.98)
Cumulative Disallowance within State		.0022	.0041
		(.22)	(.40)
Cum. Disallowed ∗ Nuke Operator		−.0234	.0013
		(−.99)	(.05)
Cum. Disallowed ∗ Nuke Owner		−.0123	−.0232
		(−.84)	(−1.40)
Number of observations	2,417	2,417	2,417
R^2 within	.1631	.1745	.1794
F-test	12.93	14.02	12.95

*** Significant at the .01 level.
** Significant at the .05 level.
* Significant at the .10 level.
t-statistics are in parentheses.

negative and highly significant, and in Model 2 cumulative dollars disallowed has a negative and highly significant coefficient. In Model 3, only the cumulative measure is significant, but a joint hypothesis test that both coefficients are zero can be rejected at the 1% confidence level. With regard to spillovers to firms in the same state that were not building a nuclear plant, all three models show them to be small, positive, and statistically insignificant; again providing no support for the "violation of the regulatory contract" hypothesis.

The story becomes more intriguing when we turn to the issue of spillovers involving utilities engaged in nuclear power plant investments. In Model 1, the interaction term between the disallowance dummy and the nuclear operator dummy is negative and highly significant, while in Model 2 the interaction term between cumulative disallowances and the nuclear operator dummy was negative but insignificant. In Model 3, which includes both interaction terms, a joint hypothesis test that the two interaction terms are both zero can be rejected at the 5% confidence level. Overall, then, there is some limited evidence of a spillover effect with regard to nuclear plant operators. This suggests at least the possibility of an unanticipated regime change or opportunistic behavior on the part of regulators with respect to operators of nuclear power plants.

In contrast to the results for nuclear plant operators, the spillover effect to firms with an ownership stake in a nuclear plant under construction was insignificant in all three models. Firms that merely had an ownership share of a nuclear power plant, but did not plan to operate the plant, did not significantly alter their investment behavior as a consequence of in-state regulatory cost disallowances.

Overall, our results with controls for nuclear construction consistently indicate that a firm that is disallowed subsequently reduces its investment propensity significantly. This provides substantial support for the hypothesis that firms suffering disallowances were not simply the victims of bad luck. In addition, there is some limited evidence of a regime shift, or regulatory opportunism, with respect to the treatment of nuclear plant owner/operators.[31] These firms may have taken disallowances as a signal that regulatory attitudes toward the operators of nuclear plants had changed, and reduced their investment plans accordingly. However, other firms, even those with ownership stakes in nuclear plants under construction, did not change their investment plans, apparently perceiving no shift in the regulatory regime they faced. Furthermore, agency problems stemming from dispersed ownership of nuclear plants may have contributed to the problems of many nuclear owner/operators.[32] Thus, while there may be some instances of regulatory opportunism in our sample, they are limited to at most one type of technology, and do not seem significant enough to support the charge that the "regulatory contract" has been irrevocably broken. Overall, the "regulatory contract" appears surprisingly robust given the extremely difficult circumstances of the late 1980s.

5. Conclusions

■ Models of regulation and regulated firm behavior typically portray an unwavering relationship between regulators and a given regulated firm. Within this framework, equilibrium behavior of the regulated firm can be derived and empirically tested. There is, however, the very real prospect that the regulatory regime, and in particular the "toughness" of regulators toward the utilities within their jurisdiction, may periodically change. Because regulators' actions are open to varying interpretations, any underlying shift in regulatory regime is unlikely to be directly observable. It is possible, though, to infer the presence of such changes in regulatory behavior by observing the behavior of utilities that are ostensibly unaffected by particular regulatory actions.

In this article we have developed a model of regulator–regulated firm interaction that is sufficiently general to accommodate the existence of such changes in regulatory behavior. We have then tested the model and its implications in a novel way. In particular, we examined whether the behavior of electric utilities in the wake of the large-scale cost disallowances of the mid-1980s is best explained by regulatory opportunism or by several alternative hypotheses. By utilizing

[31] The evidence of regulatory opportunism, even with regard to nuclear plant operators, must be interpreted cautiously. Estimations using the cumulative number of independent disallowances in a state do not support the hypothesis of a spillover effect to nuclear plant operators at conventional levels of significance, for either the fixed-effects or the Arellano-Bond estimations.

[32] The post-disallowance reductions in nuclear operator investment may be due to a perception of regulatory regime tightening. Alternatively, as discussed in footnote 31, nuclear plant operators who suffered disallowances tended to be involved in projects with dispersed ownership, which may have led to agency problems in the construction management process. A cost disallowance may have signalled that regulators had awakened to this possibility and might be more diligent in dealing with any future nuclear plants.

investment behavior of both firms that have faced disallowances and those that have not (but which are subject to the same regulatory jurisdiction as the "offending" firms), we are able to shed light on the merits of these competing hypotheses.

The empirical results do not support the proposition that there was a violation of the "regulatory contract" as a result of the cost disallowances of the 1980s. Regulators may have become more stringent in their treatment of nuclear plant operators, but they may simply have been responding to lax cost control by the operators of nuclear plants with highly dispersed ownership structures. There is no evidence of a shift in treatment of nuclear plant owners (who do not operate the plant) or of utilities building conventional generating facilities. Most utilities apparently viewed the disallowances as indicative of bad management by the affected firms and saw no reason to change their own investment practices.

As with many research efforts, the present research has opened numerous paths for subsequent analysis, which we are only beginning to explore. For example, the results presented here suggest that new theoretical work that allows for multiple firms under a single regulatory jurisdiction is likely to yield new insights into regulated firm behavior; Lyon and Li (2004) present a first step in this direction. Further empirical work identifying why firms differ in their investment behavior would also be valuable. Also, additional empirical research into the presence of regulatory opportunism and its quantitative importance appears warranted, especially work that identifies the underlying determinants and causes of shifts in regulatory behavior. This final agenda of examining the fundamental determinants of observed shifts in regulatory behavior holds promise for substantial new insights into the political economy of government-business relations.

Appendix

■ **Description of the construction of the disallowance data.** Oak Ridge National Laboratory (ORNL, 1987) inventoried 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. ORNL (1989) updated the data through 1988. LeBoeuf et al. (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 DOE 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 the rate base 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 that 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 to 1991 was \$18.335 billion, while the total disallowed for coal and other plants was \$781.915 million.

See Table A1 for a complete list of the largest disallowances.

TABLE A1 Largest Cost Disallowances by Plant

	Unit	Fuel	Utility	Disallowed ($ Million)	Year
1	Nine Mile Point 2	Nuclear	Multiple	2141	1987
2	Diablo Canyon 1&2	Nuclear	Pacific Gas & Electric Co.	2000	1988
3	Wolf Creek 1	Nuclear	Multiple	1617.6	1985
4	Shoreham 1	Nuclear	Long Island Lighting	1395	1985
5	Comanche Peak 1&2	Nuclear	Texas Utilities	1381	1991
6	Fermi 2	Nuclear	Detroit Edison Co.	1310	1988
7	River Bend 1	Nuclear	Gulf States Utilities Co.	1297	1987
8	Susquehanna 1&2	Nuclear	Pennsylvania Power & Light	847	1985
9	Clinton 1	Nuclear	Illinois Power Co.	665	1989
10	Perry 1	Nuclear	Multiple	665	1989
11	Seabrook 1	Nuclear	Multiple	646.4	1989
12	Vogtle 1&2	Nuclear	Georgia Power Co.	541	1987
13	Hope Creek 1	Nuclear	Multiple	511.6	1987
14	Callaway 1	Nuclear	Union Electric Co.	413.7	1985
15	South Texas 1&2	Nuclear	Houston Lighting & Power	375.5	1990
16	Limerick 1	Nuclear	Philadelphia Electric Co.	368.9	1986
17	Millstone 3	Nuclear	Multiple	353	1986
18	Waterford 3	Nuclear	Louisiana Power & Light	284	1987
19	Greenwood 1	FO#2	Detroit Edison	283	1986
20	Braidwood 1	Nuclear	Commonwealth Edison Co.	278.3	1988
21	San Onofre 2 & 3	Nuclear	Multiple	252	1987
22	Grand Gulf 1	Nuclear	Multiple	246.2	1988
23	Trimble County	Coal	Louisville Gas & Electric	200	1988
24	Palo Verde 1–3	Nuclear	Multiple	188	1988
25	Byron 2	Nuclear	Commonwealth Edison	180.6	1988
26	Beaver Valley 2	Nuclear	Multiple	125.3	1989
27	Summer 1	Nuclear	South Carolina Electric & Gas	123	1984
28	Hunter 3	Coal	Utah Power & Light	112.5	1986
29	Byron 1	Nuclear	Commonwealth Edison	101.5	1985
30	Belle River 1&2	Coal	Detroit Edison	96.87	1985
31	Bath County	PS	West Penn. Power	31	1987
32	Helms 1–3	PS	Pacific Gas & Electric	21.99	1985
33	Daniel	Coal	Mississippi Power	19	1981
34	Kettle Falls	Water	Washington Water & Power	9	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	.5	1985

FO#2 = #2 Fuel Oil.
PS = Pumped Storage.

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