

Nuclear Power Plant Cancellations: Sunk Costs and Utility Stock Returns

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Abstract

This study empirically examines the impact of decisions to cancel nuclear power plants on electric utility common stockholders. The reaction of common stock prices to initial announcements of 58 nuclear power plant cancellations covering the period 1974 through 1984 is analyzed. Decisions to cancel nuclear power plants under construction were associated with significant negative excess stock returns. Furthermore, the larger the sunk costs relative to a utility's common equity at the time of the cancellation, the larger the stock price decline, on average. This relationship was more evident as regulators moved toward allocating relatively greater proportions of the sunk costs to investors.

Introduction

In May 1982, Duke Power announced that it was canceling its Cherokee nuclear power plant. Duke Power had invested over \$633 million in the partially completed plant. This sunk cost figure represented over 30 percent of Duke's precancellation net worth. Cincinnati Gas and Electric, with two other electric utilities (American Electric Power and Dayton Power and Light), announced the cancellation of the Zimmer nuclear power plant in October 1983. Zimmer's total sunk costs equaled approximately \$1.8 billion; Cincinnati's share amounted to \$716 million or almost 90 percent of the utility's 1982 net worth.

The Cherokee and Zimmer cancellations are two examples of the recent substantial reduction in the commitment to nuclear power by U.S. electric utilities. Since 1972, over 120 nuclear units have been canceled by electric

*The authors thank an anonymous referee for his or her detailed comments on an earlier version of this paper. Particularly useful insights into the regulatory process and how stockholders might be expected to react to situations involving regulatory uncertainty were provided.

utilities; over \$15 billion had been spent on these units. These cancellations represented over one-half of the total previously ordered nuclear generating capacity, and no new nuclear units have been ordered since 1977.

The decision to cancel a nuclear power plant is important in terms of its impact on the affected utility's future cash flows. Even in a favorable regulatory environment, the affected utility rarely will be allowed a sunk cost recovery system that results in a zero net present value. As a result, the initial announcement of a nuclear power plant cancellation should be treated by stock market investors as a negative informational event. Furthermore, larger price declines should be associated with cancellations involving larger sunk costs.

This study examines utility stock price reactions around nuclear power plant cancellation announcements. A sample of utilities announcing nuclear power plant cancellations between 1974 and 1984 was identified, and sunk cost data were collected for each cancellation. Possible evidence of significant daily stock price movements around the announcement date was sought. Several tests were conducted to determine if the distribution of individual excess returns can be explained by the size of sunk costs.

Nuclear Power Plant Developments

At one time, nuclear power was thought to be one of the keys to the nation's energy future. In the early 1950s, the federal government embarked on a program designed to encourage private industry involvement in the generation of electricity via nuclear power. Restrictions on the participation in nuclear-related activities by private organizations and individuals were eased, and a program of federally sponsored liability insurance for utilities, in the event of a nuclear power plant accident, was established.¹

In addition to the federal government, nuclear power plant manufacturers also provided an incentive to electric utilities. During the early 1960s a number of turnkey plants were built to demonstrate the feasibility of nuclear technology. The manufacturer, rather than the utility, absorbed losses associated with cost overruns. The burden of cost overruns, however, shifted to the utility after the mid-1960s as new reactors typically were ordered on a cost plus basis. (See Luftig and Enholm [13].)

By the end of 1972, there were 28 private nuclear power reactors in commercial operation [19]. Fifty investor-owned electric utilities were operating and/or planned reactors by 1974. These utilities were expected to build

¹*Public Law 85-256 (71 Stat 576 [1957])*. Under this act, which is referred to as the Price-Anderson Act, the U.S. government assumed nuclear-related liability claims up to \$560 million per accident. Several extensions and modifications of this legislation have occurred since the initial law was passed.

and operate a total of 197 reactors by the end of the century [20]. These ambitious construction plans led to forecasts that nuclear power eventually would provide one-half of the nation's electricity [19].

The latter part of the 1970s saw a dramatic shift in nuclear power plant construction plans. Four factors have been identified.² Forecasts of peak load growth were revised sharply downward. Unfavorable capital market conditions put constraints on external funding. The Three Mile Island (TMI) accident in 1979 raised questions about the long-term safety and environmental impact of nuclear power plants. Finally, construction delays and cost overruns began to plague the industry. In addition, there was an increase in the uncertainty of regulatory treatment of plants about to be placed in service. The possibility of large rate increases led to regulatory actions, including prudence tests, rate base disallowances, and phase-ins of nuclear plants over a number of years.

Given this situation, it is not surprising that in recent years the financial markets have taken a generally negative view of a utility's commitment to nuclear power. Berry and Laudenslager [2], for example, find that nuclear power plant construction activity resulted in a pretax increase in the affected utility's costs of capital of 51 basis points. This, they argue, was due to increased investor-perceived risk related to nuclear power plants. An increase of 51 basis points in the affected utility's cost of capital would increase its revenue requirements by approximately \$1 billion. Hewlett [11] and Melicher, Hearth and Uskert [15] find evidence that total stock returns were lower in recent years for nuclear utilities, when compared to nonnuclear utilities.

In addition, a number of studies have examined the impact of the TMI accident on utility security returns. Bowen, Castanias, and Daley [3], Hill and Schneeweis [12], and Fraser and Kolari [9] all find evidence that the TMI accident had a negative affect on utility stock prices. This affect also appeared to be far more pronounced for nuclear utilities. Barrett, Heuson, and Kolb [1] find that there was a negative industry-wide effect on utility bond risk premia due to TMI. They also find that the nuclear effect on risk premia was a result of the existence of a utility's commitment to nuclear power.

All of these factors, no doubt, led many utilities to cancel a number of nuclear power plants actually under construction or simply on order. Furthermore, no new nuclear power plants have been ordered since 1977.

²A complete discussion of these four factors is contained in [21].

Regulatory Issues in Nuclear Power Plant Cancellations

Public utility regulation in the United States is designed to balance the costs to consumers on the one hand and the rate of return to shareholders on the other hand. A principal task of regulators is to set output prices that will achieve such a balance. The legal basis for determining an appropriate rate of return was established in the U.S. Supreme Court decisions in the *Bluefield* and *Hope* cases.³ This allowed return should be equal to the returns on comparable risk firms, enabling the maintenance of existing equity capital and the attraction of new capital. Today, the consensus is that an appropriate rate of return should be a market-determined expected return. Furthermore, this allowed rate of return should be set equal to the cost of capital so that the utility's market value will be equal to its rate base value.

McConnell and Muscarella [14] contend that unexpected changes (increases or decreases) in public utility capital expenditure plans will not be associated with changes in their stock prices. McConnell and Muscarella find that utility stock prices did not react to changes in capital investment decisions. In contrast, an increase (decrease) in investment expenditure plans by industrial firms is associated with an increase (decrease) in stock prices.⁴ McConnell and Muscarella apparently did not examine nuclear power plant cancellations.

The conditions for zero net present value in a nuclear power plant cancellation require that the affected utility be allowed to recover all of its sunk costs through increased future cash flows. This means that sunk costs would have to be amortized over a specific number of years, with the unamortized balance added to the utility's rate base. If the utility is allowed to earn a rate of return equal to its cost of capital, the present value of the future cash flows would be equal to the sunk costs. Some regulatory decisions have met these conditions; however, many have not.⁵

The traditional tests used by regulators (the prudent investment test and the used and useful test) when deciding whether utilities should be allowed to recover

³*Bluefield Water Works and Investment Company v. Public Service Commission of the State of West Virginia* (262 U.S. 679 [1923]) and *Federal Power Commission v. Hope Natural Gas Company* (320 U.S. 591 [1944]).

⁴Myers and Majluf [16] contend that changes in investment plans are signals concerning future cash flows. A more general theory of the relationship between changes in future cash flows and stock prices is referred to as the *implied cash flow change hypothesis* (e.g., see Smith [18]).

⁵See [8, 10, 17] for surveys of regulatory decisions and discussions of regulatory theory concerned with the recovery of sunk costs associated with nuclear power plant cancellations.

the costs of an investment are more difficult to apply to canceled plants. A canceled plant never will be used. Regulators often have relied on these traditional tests, however, when deciding whether and how to allow the recovery of sunk costs. Generally, the regulators have found that utilities acted prudently with respect to the canceled plants.

A finding of prudence, however, is no guarantee that the conditions for zero net present value will be met. Many regulators have used the notion of risk-sharing in their decisions on sunk cost recovery.⁶ The notion of risk-sharing states that because both ratepayers and investors share in the benefits of a completed plant, they must share the costs if the plant is canceled prior to completion. Thus, in many cases, regulators have allowed sunk costs to be amortized, but have not allowed the unamortized portion into the rate base. As a result, the net present value of the cancellation is negative.

In several jurisdictions, utilities were denied any recovery of sunk costs, regardless of a finding of prudence. The origin of many of these decisions can be traced to a 1981 case where the Ohio Supreme Court overturned a ruling by that state's public utilities commission.⁷ The Ohio Commission ruled that Cleveland Electric Illuminating (CEI) acted prudently and was entitled to recover some of the costs associated with the cancellation of several nuclear power plants. The Ohio court held that sunk costs associated with a canceled investment were extraordinary losses and not recoverable, however, regardless of a finding of prudence.⁸ Although the ruling in the CEI case did not set strict precedent for other jurisdictions, it appears to have signaled an overall change in regulatory philosophy, the end result of which has been to allocate an increasing share of sunk costs to investors [10].

Testable Predictions and Empirical Issues

The preceding discussion provides a number of hypotheses that can be tested empirically. The first is that an announcement of a nuclear power plant cancellation should be treated by investors as a negative informational event. Due to the regulatory treatment of sunk costs, nuclear power plant cancellations

⁶The concept of risk-sharing originated in a Federal Energy Regulatory Commission ruling in 1980 and has been used by a number of state commissions. For further discussion, see Hearth, Melicher, and Gurley [10].

⁷*Office of Consumers' Counsel, et al. v. Public Utilities Commission of Ohio* (423 NE 2d 820 [1981]).

⁸The Ohio Supreme Court reaffirmed this decision in three subsequent decisions.

usually have been negative net present value decisions. There are two prior studies that have examined this issue, but their results are somewhat contradictory. Chen, Fanara, and Gorman [5] examine 24 cancellation announcements that occurred between 1974 and 1982. Although cancellations that were announced prior to TMI were associated with negative price movements, those announced following TMI were associated with slightly positive price movements. DeBondt and Makhija [7] examine 26 cancellations that were announced between 1977 and 1984 and involved at least \$50 million in sunk costs. They find strong evidence of negative price movements around the cancellation announcement.

Given the importance of sunk costs in determining the net present value of the cancellation, this paper's second hypothesis states that larger negative price movements should be associated with cancellations involving larger sunk costs. This issue has not been addressed directly by prior studies.

The third hypothesis states that larger negative price movements should be observed for cancellations that occurred after the CEI ruling in 1981. As discussed in the prior section, the overall affect of the CEI ruling appears to be that investors will pay a larger share of the sunk costs. Therefore, the net present value of cancellations that occurred after the CEI ruling will be even more negative than they were prior to CEI.

To test these hypotheses, a sample of nuclear power plant cancellations has been collected. Approximately 94 independent cancellations, representing 60 investor-owned electric utilities, were identified from three sources.⁹ For each member of this preliminary sample, an attempt was made to identify a clean initial cancellation date and the amount of sunk costs involved. Each announcement was screened for the presence of other announcements (e.g., a change in dividend policy). Clean announcements and/or sunk cost data could not be identified for some members of the preliminary sample, and they were dropped. The final sample consists of 58 cancellation announcements. Daily stock price data were collected for each member of the final sample from the CRSP database.

Table 1 presents some descriptive statistics for the final sample. Panel A reports the distribution of event years. Cancellations were announced between 1974 and 1984, with the largest number occurring in 1979. Of the 58 cancellations, 33 were announced prior to the CEI ruling versus 25 after the CEI ruling, as shown in Panel B.

Panel C of Table 1 presents some descriptive data on the variable called *standardized sunk costs* that is measured as the dollar amount of sunk costs

⁹See Edison Electric Institute [8], Luftig and Enholm [13], and U.S. Department of Energy [21].

divided by the market value (stock price times number of shares outstanding) of the affected utility's equity the year prior to the cancellation announcement.¹⁰ Sunk costs, on average, are substantial relative to the equity base of the affected utilities. They range from a low of .23 percent to a high of 245 percent, with a mean of approximately 27 percent.

Standard event study methodology is employed to test the presence of significant daily price movements around nuclear power plant cancellation announcements. More specifically, the mean-adjusted return methodology (see Brown and Warner [4]) is used to determine whether significant negative stock price returns occur around the announcements. Regression analysis and nonparametric statistical test procedures then are used to test hypotheses two and three.

Principal Findings

Average abnormal returns for the cancellation sample have been calculated for a period beginning 60 days prior to initial cancellation announcements and ending 30 days following the same announcements. (These results are available from the authors.) Table 2 summarizes the timing and significance of the abnormal returns (AR). The results provide strong support for the hypothesis that nuclear power plant cancellation announcements are negative informational events.

During a six day window surrounding the cancellation announcement (day -5 through day 0), four significantly negative average abnormal returns are observed (day -5, day -2, day -1, and day 0). Outside this window, average abnormal returns exhibit essentially random drift. The largest daily average abnormal returns are observed on day -2, day -1, and day 0 (-.99 percent, -.95 percent, and -.33 percent respectively). The cumulative average abnormal return for the three day subperiod (day -2 through day 0) equals -2.30 percent. Its associated *t* statistic (*t* = -14.56) is significantly negative at any reasonable level of statistical significance.

A closer examination of the individual abnormal returns confirms the conclusion that the cancellation announcement is a negative informational event. For both day -2 and day -1, 38 of the 58 individual abnormal returns are negative. Using the sign test, the binomial probability of obtaining 38

¹⁰Market value of equity is used instead of book value to deal with the possibility that regulators adjust other parts of the rate setting mechanics to allow some recovery of sunk costs. This was suggested by an anonymous referee, and the use of market values is consistent with the work by Christie [6].

successes from 58 trials (where the probability of a success equals $1/2$) is small (the associated Z-statistic equals 2.37).

Summarized in Table 3 are the results of a Mann-Whitney nonparametric test designed to determine if the market reaction to nuclear power plant cancellations differs based on whether the cancellation occurred prior to or following the ruling in the 1981 CEI case. Because the overall impact of the CEI ruling was to restrict sunk cost recovery further, it would be expected that larger negative price movements would be observed for cancellations that were announced after CEI. The results support this contention.

The sum of the individual abnormal returns for each utility over the period day -2 through day 0 (TOT) are ranked from smallest to largest. The mean rank for the pre-CEI group is 35.44, while the mean rank for the post-CEI group is 21.66. This difference is statistically significant at the 1 percent level (the associated Z-statistic equals -3.08).

Table 4 summarizes the results of a cross sectional regression model. This model is designed to test the relationship between sunk costs and the market reaction to nuclear power plant cancellations. In addition, the model also explicitly tests for possible interaction between sunk costs and the CEI ruling.

The model's dependent variable is TOT (the sum of individual abnormal returns over the period day -2 through day 0). The independent variables are standardized sunk costs (SSC) and a dummy variable (0, 1) indicating whether the cancellation was announced prior to or following the CEI ruling. In order to test explicitly for interaction between sunk costs and the CEI ruling, SSC is split into two variables (SSC1 and SSC2). For cancellations that were announced prior to CEI, SSC1 equals standardized sunk costs and SSC2 equals zero. For cancellations that were announced after CEI, SSC2 equals standardized sunk costs and SSC1 equals zero. It is expected that $(b_1 - b_2)$ will be positive, while the three individual coefficients will be negative.

The results show that the SSC2 coefficient is negative (-.0844) and is strongly statistically significant ($t = -4.80$). Contrary to expectations, the SSC1 coefficient is positive (.0390). It is not, however, statistically significant ($t = 1.03$). The $(b_1 - b_2)$ coefficient is both positive (.1234) and strongly statistically significant ($t = 2.99$), consistent with expectations. Finally, the CEI coefficient is negative, though it is not statistically significant ($t = -.37$). As indicated by the model's R-squared (.41) and F-value (12.45), the model provides an adequate explanation of the variation in individual abnormal returns.

These results provide insight into the relationship between sunk costs and stock price reaction to nuclear power plant cancellations. In general, larger negative price movements are associated with cancellations that involve larger sunk costs (relative to the market value of the affected utility). This is consistent with the notion that nuclear power plant cancellations are generally

negative net present value decisions and the larger the sunk costs, the greater this negative net present value. More specifically, however, the results clearly show that the strong negative relationship between sunk costs and investor reaction to nuclear power plant cancellation announcements is dependent on the overall regulatory environment. Due to the somewhat ambiguous regulatory treatment of sunk costs prior to the CEI ruling, this relationship is noisy. Following the CEI ruling, because regulators have allocated an increasing share of sunk costs to investors, the negative relationship is evident. After CEI, common stock investors apparently believed that utilities would be allowed to recover little of their existing sunk costs when they announced decisions to cancel nuclear power plants that were under construction.¹¹

Summary and Conclusions

The impact of decisions to cancel partially completed nuclear power plants on electric utility common stockholders was examined empirically in this study. A total of 58 cancellations covering the period 1974 through 1984 were analyzed. Of particular interest was the relationship between sunk costs and common stock prices in light of changing regulatory conditions.

Decisions to cancel previously ordered nuclear power plants or plants under construction were found to be associated with significantly negative abnormal stock returns. This is consistent with the notion that nuclear power plant cancellations are generally negative net present value decisions. Furthermore, the larger the sunk costs relative to the market value of the affected utility's common equity at the time of the cancellation, the larger the stock price decline, on average. This relationship was most apparent as state regulatory commissions moved increasingly more toward allocating most, if not all, sunk costs to investors rather than ratepayers.

¹¹ An anonymous referee suggested that if regulators were excluding all the sunk cost from the rate base and perfectly imposing the requirement that the expected return from items in the rate base equalled the cost of capital, then the standardized sunk cost variable in the regression equation would indicate the stock market's probability assessment regarding possible cancellation prior to the actual act. Furthermore, because regulators had more freedom to manipulate other parts of the rate setting machinery to compensate investors for the write-off of nuclear power plants prior to the 1981 CEI ruling, the standardized sunk cost coefficient would be relatively smaller (i.e., a lower probability) for earlier cancellations. This interpretation is tenuous, as all sunk costs have not been excluded from rate bases and there is no way of knowing whether associated regulatory treatments were perfectly imposed. The standardized sunk cost coefficient, however, was found to be smaller (insignificantly positive) before the CEI ruling and larger (significantly negative) after the ruling.

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Table 1
Descriptive Characteristics of Nuclear
Power Plant Cancellation Sample

A. Number of Cancellations by Year

Year	Number Announced	Year	Number Announced
1974	1	1980	6
1975	2	1981	8
1976	0	1982	9
1977	1	1983	4
1978	4	1984	<u>7</u>
1979	16	Total	58

B. Number of Cancellations Before and After the Cleveland Electric Illuminating (CEI) Case Ruling

	Number
Pre CEI Ruling	33
Post CEI Ruling	<u>25</u>
Total	58

C. Standardized Sunk Costs

Mean	27.17%
Standard Deviation	42.59
Median	11.97
Range:	
High	245.05
Low	.23

NOTE: The standardized sunk costs variable is measured as the percentage of sunk costs relative to the market value of the affected utility's equity the year prior to the cancellation

Table 2
Summary of Abnormal Returns Around Nuclear
Power Plant Cancellation Announcements

Event Day	Average AR	T-Statistic	Individual AR + / -
-5	-.21%	-2.33 ^a	21/37 ^b
-4	.15	1.67	26/32
-3	.03	.33	30/28
-2	-.99	-11.00 ^a	20/38 ^b
-1	-.95	-10.56 ^a	20/38 ^b
0	-.33	-3.67 ^a	24/34
-2, -1, 0	-2.27	-14.56 ^a	22/36 ^b

NOTE: AR refers to the abnormal returns

^aSignificant at the 1 percent (or higher) level

^bSign test significant at the 10 percent (or higher) level

Table 3
Summary of Mann-Whitney Test for Differences in
Individual Abnormal Returns Relative to the CEI Ruling

H_0 : TOT_j does not differ relative to CEI ruling
 H_a : Otherwise

Group	Mean Rank
Pre CEI Ruling	35.44
Post CEI Ruling	21.66

Mann-Whitney Z Statistic = -3.08^a

NOTE: TOT_j equals the sum of individual abnormal returns for utility j over the period day -2 through day 0

^aSignificant at the 1 percent (or higher) level

Table 4
Summary of Standardized Sunk Costs Regression

Model: $TOT_j = b_0 + b_1SSC1_j + b_2SSC2_j + b_3CEI_j + u_j$

Coefficient	Estimate	T-Statistic
b ₀	-.8119	-.77
b ₁	.0390	1.03
b ₂	-.0844	-4.80 ^a
b ₃	-.5957	-.37
(b ₁ - b ₂)	.1234	2.99 ^a
R-Squared	=	.41
F-Value	=	12.45 ^a

NOTE: SSC1 equals standardized sunk costs if the cancellation was announced prior to the CEI ruling (1 otherwise), SSC2 equals standardized sunk costs if the cancellation was announced after the CEI ruling (0 otherwise), and CEI is a (0, 1) dummy variable indicating whether the cancellation was announced prior to or following CEI

^aSignificant at the 1 percent (or higher) level

