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THE LIABILITY EQUIVALENCE OF UNFUNDED NUCLEAR DECOMMISSIONING COSTS

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THE LIABILITY EQUIVALENCE OF
UNFUNDED NUCLEAR DECOMMISSIONING COSTS

Abstract

For public health and safety reasons, a nuclear power plant needs to be decommissioned at the end of its useful life. In a recent report, the General Accounting Office (GAO 1999, p. 16) has called into question the adequacy of funding for decommissioning. In the context of the ongoing deregulation of the electric utility industry, there is considerable uncertainty at this time as to how much of the unfunded decommissioning costs will be recovered from ratepayers.

In this study, we utilize alternative current cost and present value estimates of unfunded decommissioning costs to investigate whether investors are cognizant of these potential claims on utility net assets. Our findings are largely consistent with the recent Financial Accounting Standards Board (2000, ¶ 5) exposure draft which indicates that decommissioning costs should be recognized in the financial statements as a liability. However, the results suggest that unfunded decommissioning obligations have a smaller incremental negative effect on the stock price than other utility liabilities indicating that investors expect partial recovery of these unfunded costs from ratepayers. Given the uncertainty inherent in present value estimates and the uncertainty associated with the future recoverability of unfunded decommissioning costs from ratepayers, additional disclosures may mitigate uncertainty and facilitate investor assessment of these potential obligations.

THE LIABILITY EQUIVALENCE OF
UNFUNDED NUCLEAR DECOMMISSIONING COSTS

1. INTRODUCTION

In a recent study, the General Accounting Office (1999, p. 16) has called into question the adequacy of funding for decommissioning the nation's nuclear power plants.[1] Normally, these costs would likely be recovered from customers (ratepayers) as part of the cost-based regulated price for electricity (GAO, 1999, p. 11) . However, in the context of the unfolding deregulation of the electric utility industry, there is considerable uncertainty as to the recoverability of these unfunded costs from ratepayers (GAO, 1999, p. 2) .

Jensen (1986, p. 11) suggests that the stock market is forward looking and that the stock price incorporates an infinite time horizon. Further, stockholders represent the residual claimants in a firm. Thus, to the extent that investors (stockholders) perceive that unfunded decommissioning costs will be recovered from ratepayers, there will be no perceived claim against utility net assets and no effect on the stock price. However, to the extent that investors perceive that unfunded decommissioning costs will *not* be recovered from ratepayers, the unfunded costs are likely to be viewed as a potential claim against utility net assets and priced by the market as a liability.

Separately, the Financial Accounting Standards Board (FASB, 2000, ¶ 9) has issued an exposure draft of a new proposed statement of accounting standards indicating that decommissioning costs should be recognized as a liability at the time of initial plant operation. The objective of standard setting is to produce financial statements that facilitate informed decision making by investors (Levitt, 1998, p. 79). The standard setting process itself involves answering normative questions such as whether an item (e.g., the obligation to decommission a nuclear power plant) should be recognized

[1]For public health and safety reasons, a nuclear power plant needs to be decommissioned at the end of its useful life. Decommissioning a nuclear plant is a costly process, since it involves not only dismantlement but also decontamination of radioactive equipment and buildings (GAO, 1999, p. 10).

in the financial statements and how it should be measured (Schipper, 1994, p. 62). As a general rule, proposed standards involve the reporting of new information which enters the public domain only some time after the final standard is issued. However, as discussed below, in this particular instance pertinent information about nuclear decommissioning obligations can be processed from currently available data.

Our study is motivated by the question, are investors cognizant of currently available information about unfunded decommissioning costs? Our objective is to assess whether these potential obligations are priced by investors as equivalent to other utility liabilities. Hence, our study is in the nature of *ex ante* research (Schipper, 1994, p. 62), i.e., research that deals with an item that is being considered by standard setters. To paraphrase Schipper (1994, p. 62), the evidence we present is policy relevant since it could potentially shift (or solidify) standard setters' existing beliefs about the current proposal to treat decommissioning costs as a liability.

The sample consists of 95 firm-year observations of electric utilities with nuclear power plants over the 1995-1997 period. In the context of our valuation model, we investigate whether the pricing coefficient for alternative current cost and present value estimates of unfunded decommissioning costs is equal to the coefficient for other liabilities. We also investigate the relevance of two utility-specific factors (regulatory environment and financial risk) for investor pricing of unfunded decommissioning costs.

Our results indicate that investors are cognizant of unfunded decommissioning costs although the evidence suggests that these obligations have a smaller incremental negative effect on the stock price than other utility liabilities, i.e., these obligations are priced as if investors expect partial recovery of unfunded decommissioning costs from ratepayers. The results also suggest that investor pricing of unfunded decommissioning costs is influenced by the regulatory climate and financial risk. Specifically, a dollar of unfunded decommissioning costs appears to have a greater incremental negative effect on the stock price of a utility operating in an *un*favorable regulatory climate (i.e., a regulatory environment *un*favorable to utility stockholders) or rated by Moody's (1995, p. 3497) as financially riskier. Collectively, our findings point to the need for additional disclosures in utility financial statements about the nature and future outcomes of nuclear operations so as to help mitigate investor uncertainty about the magnitude and recoverability of decommissioning costs from ratepayers.

The rest of our paper is organized as follows: The next section provides background information about the rate-regulated electric utility industry and discusses (1) the potential implications of unfunded decommissioning costs for stockholders in the context of deregulation, and (2) the Financial Accounting Standard Board (FASB, 2000, ¶ 5) exposure draft on the accounting for decommissioning costs. Section 3 discusses our methodology, hypotheses, and data. Section 4 presents our empirical findings, and section 5 concludes the paper.

2. INSTITUTIONAL BACKGROUND

The electric utility industry represents the "largest" industry in the United States (U.S.) with total assets and revenues in 1993 of "$700 billion" and "$200 billion," respectively (General Accounting Office, 1999, p. 10). Traditionally, electric utilities have been viewed as natural monopolies, i.e., enterprises that could provide services at the lowest cost only if they were protected from competition (Hyman, 1994, p. 4). Consequently, investor-owned utility companies operated as rate-regulated enterprises with state-established public utility commissions (PUCs) agreeing to set rates high enough for these firms to recover prudent and reasonable costs plus a fair rate of return (profit) on their asset base (Hyman, 1994, p. 5).

In the 1950s, nuclear technology was perceived as ushering in an era of declining unit costs in which electricity would eventually become "too cheap to meter" (Hirsh, 1997, p. 29). Moreover, nuclear power was viewed by environmentalists as the answer to fossil-fuel pollution (Hyman, 1994, p. 36). The resulting large scale construction of nuclear power plants was supported by the broader milieu of rate-regulation which suggested a "field of dreams" approach to management, i.e., build it and they will pay for it (Vesey, 1997, p. 53). Unfortunately, intensifying safety concerns subsequent to the 1979 accident at Three Mile Island increased the complexity of nuclear plants and resulted in significant construction cost overruns as well as mounting operating costs that triggered customer resistance to escalating utility rates (Hirsh, 1997, p. 29).

According to the GAO (1999, p. 10) nuclear power plants in the U.S. provide "about 20 percent" of the nation's electricity output. With the benefit of hindsight, these nuclear plants have turned out to be more expensive to operate than fossil-fuel plants on account of technical safety problems, frequent closings, and costly repairs (Hyman, 1994, p. 143). In addition to higher operating costs, nuclear plants face a costly process of decommissioning, i.e., dismantlement and decontamination, at the end of their useful lives (GAO, 1999, p. 10). For economic as well as reliability reasons, a number of nuclear plants have been shut down at the end of only 10-15 years of operations rather than the initially estimated 40 years (GAO, 1999, p. 19). According to the GAO (1999, p. 5), rate-regulators have allowed utilities to continue billing their customers for the decommissioning costs of prematurely retired plants.

Relative to fossil-fuel plants, nuclear plants are much more expensive to dismantle largely because of decontamination costs (GAO, 1999, p. 10). At the end of 1997, the GAO (1999, p. 2) estimated the baseline discounted present value amount of nuclear decommissioning costs to be $30 billion with $14 billion of those costs currently *un*funded. The Nuclear Regulatory Commission (NRC), which regulates public health and safety issues associated with nuclear power operations, holds the plant licensee (the utility) responsible for the costs associated with eventual decommissioning (GAO, 1999, p. 2). Hence, a utility cannot avoid the responsibility of paying for nuclear decommissioning. Still, in a rate-regulated environment, the burden of unfunded decommissioning costs can be expected to fall on customers (in the form of higher electricity rates) rather than on utility stockholders.

2.1 Deregulation and the specter of stranded costs

In the aftermath of the energy crisis in the early 1970s, the federal Public Utility Regulatory

Policies Act (PURPA) of 1978 deregulated the generating sector of the utility industry by allowing small non-utility companies to sell their excess power through the grids created and maintained by the regulated utility firms (Hirsh, 1997, p. 30). Without affecting the transmission or the distribution sector of the industry, PURPA eliminated the barrier to entry in the electricity-generation market (Hirsh, 1997, p. 32). More recently, new technologies have made it possible for non-utility companies to generate power on a small-scale basis and at low cost, thus undermining the basic argument for a natural monopoly (Hirsh, 1997, p. 34). At this time, "a patchwork of unfolding national and state deregulation has put the restructuring (of the electric utility industry) in motion, but there is no defined end point" (Navarro, 1996, p. 112).

Under deregulation, the price of electricity would be set by competitive markets rather than by regulators. For the utility industry, deregulation poses a dire financial threat in the form of so-called stranded costs which basically represent investments in plants that are no longer economically viable, i.e., investments in plants whose cost of production is too high to earn a satisfactory return given the competitive market price for electricity (Navarro, 1996, p. 114). It is true that decommissioning costs are different from other power plant investments (such as construction costs) in that they have to be paid for not at the beginning but at the end of the economic life of the plant. Still, for electric utilities with nuclear power plants, unfunded decommissioning costs represent potential stranded costs in that there is no guarantee that these costs can be recovered from ratepayers in a competitive marketplace (Navarro, 1996, p. 116).

The basic argument for full recovery of stranded costs (in the form of higher electricity rates) is equity or fairness, since construction of the admittedly uncompetitive power plants was in fact approved by regulators as part of an implicit fair rate-of-return regulatory compact (Baumol and Sidak, 1995, p. 23).[2] The counter-argument is that the decision to build many of the nuclear plants

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[2]The basic argument is that rate-regulation historically has maintained symmetry, i.e., denied stockholders the opportunity for big gains (by protecting consumers from price gouging)

was "imprudent" to begin with, i.e., the plants were "inefficient, unneeded, and known to be so at the time of construction commitments;" hence, the costs associated with these plants should be disallowed by rate-regulators (Michaels, 1995, p. 24). Similarly, Navarro (1996, p. 116) indicates that rate-regulation has created a bloated and inefficient electric utility industry and that a policy of no recovery at all of stranded costs would be best in terms of promoting the global competitiveness of electricity-intensive U.S. industries such as autos or semiconductors. Still, Navarro (1996, p. 124) suggests that a policy of partial recovery, e.g., a fifty-fifty sharing of stranded costs between ratepayers and stockholders, is likely to be more feasible politically than a policy of zero recovery.

The basic question that remains is that in the end who will bear the burden of unfunded decommissioning costs, the customers (ratepayers) or the utility stockholders? To the extent that full recovery of these costs is permitted by the rate-regulators, the utility's customers would pay for these costs and stockholders would not be any worse off since they would still be able to earn the implicit fair rate-of-return on their investment. Navarro (1996, pp. 116, 124) suggests that the Federal Energy Regulatory Commission (FERC) and the California Public Utilities Commission have endorsed full recovery of stranded costs.[3] Also, as noted previously, the GAO (1999, p. 5) indicates that at present the state PUCs continue to allow nuclear plant licensees to continue to collect funds for decommissioning from customers even for plants that have been prematurely retired from service.[4]

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while sheltering investors from the risk of large losses (Baumol *et al.*, 1995, p. 38). Although rate-regulators and customers would like to void past commitments that have not met expectations, any attempt to abandon symmetry would change the rules of the game ("heads-we-win, tails-you-lose") and result in an illegal taking of investors' property (Baumol *et al.*, 1995, p. 38).

[3]Rate-regulation of electric utilities rests with the FERC for wholesale transactions and with the state public utility commissions (PUCs) for retail sales (GAO, 1999, p.11).

[4]However, a preliminary ruling by an administrative law judge of the FERC cited "imprudence" in disallowing an investor owned utility from collecting $200 million from ratepayers (out of an estimated total cost of $427 million) for decommissioning the prematurely retired Connecticut Yankee nuclear power plant (Connecticut Yankee Atomic Power Company, 84 FERC Reports (CCH) ¶ 63,009 (August 31, 1998)).

Over the next 10 years, deregulation of the generation (if not the transmission and distribution) of electricity is likely to take hold in many states and the resulting competition could make it difficult to raise adequate decommissioning funds from customers in the form of higher electricity rates (GAO, 1999, p. 13). Still, even under competitive market conditions, rate-regulators could make customers pay for stranded costs by imposing exit fees or other tariffs on those who want to switch to alternative lower-cost suppliers of electricity (Aggarwal, 1997, pp. 104-105).

Overall, three alternative outcomes are conceivable for the future. First, the rate regulators permit full recovery of unfunded decommissioning costs from ratepayers. Second, the regulators permit only partial recovery. Finally, the regulators (particularly in the context of deregulation) permit no recovery at all of unfunded costs. To the extent that rate-regulators (or competitive market conditions) permit only partial or zero recovery from ratepayers, a portion or all of the unfunded decommissioning costs would represent a potential claim against utility net assets (stockholders equity) and depress equity prices.

2.2 Accounting for decommissioning costs and the proposed FASB statement

Currently, for purposes of both rate-making and financial reporting to investors, nuclear decommissioning costs are recognized ratably (as an element of depreciation) over the life of the plant (Ferguson, 1997, p. 44). The obligation to decommission a nuclear plant is treated as a cost of providing service and is accrued over the economic life of the plant. Thus, over the life of the plant, additional depreciation expense is recorded each year with the offsetting credit going either to accumulated depreciation or to a liability account (Boatsmam et al., 2000, p. 213).[5] In a rate-regulated environment, the additional depreciation expense permits the utility to collect additional revenues from customers which are then invested (in compliance with NRC regulations) in external trust funds

[5]Approximately two-thirds (22 out of 32) of our sample firms credited accumulated depreciation; the remaining firms credited a liability account.

to accumulate resources for decommissioning (GAO 1999, p. 13).

Boatsman *et al*. (2000, p. 213) note that in 1994, the Edison Electric Institute (which is the trade association for investor-owned electric utilities) asked the FASB to address the issue of how to account for nuclear decommissioning costs. To date, the FASB has issued two exposure drafts.[6] According to the FASB (2000, ¶ 73), the liability for nuclear decommissioning is incurred at the time the "facility is operated and contamination occurs" and should be recorded at that time at the present value of estimated future decommissioning costs.[7] Further, the liability should be recorded (a credit entry) with an offsetting debit to the historical cost of the plant (FASB, 2000, ¶ 11).[8] The asset component (the present value of the decommi-ssioning costs included in the cost of the plant) will be depreciated over the life of the plant (FASB, 2000, ¶ 11). In addition, there will be interest expense each year as the recorded liability increases with the passage of time (FASB, 2000, ¶ 21). From an industry (preparer) perspective, Ferguson (1997, p. 44) notes that the potential drawbacks of the proposal are (1) the reporting of a liability (which would adversely affect financial ratios, such as the debt to total assets ratio, for electric utilities with nuclear plants), and (2) the backloading of costs

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[6]The exposure drafts (FASB, 1996 and FASB, 2000) address accounting for obligations associated with the retirement of tangible long-lived assets not only in the electric utility industry but also other industries such as landfills, hazardous waste storage facilities, and offshore oil and gas production facilities.

[7]The key difference between the two drafts (FASB, 1996 and FASB, 2000) is that the revised draft requires the initial measurement of a liability for asset retirement to be at fair value, where fair value is the amount that the utility would pay in an active market to a willing third party of comparable credit standing to assume all of the duties, uncertainties, and risks inherent in the utility's obligation (FASB 2000, ¶ 13). However, the FASB notes that a market for settling asset retirement obligations will normally *not* exist so that in most cases the discounted present value of estimated future decommissioning costs will be used in lieu of fair values (FASB, 2000, ¶15).

[8]A debit to plant assets with an offsetting credit to a liability account would *not* decrease stockholders equity immediately in bookkeeping terms. Still, as discussed at greater length in the next section, to the extent that the second and third outcomes (partial or zero recovery from ratepayers) identified previously in section 2.1 are viewed by investors as likely, the unfunded decommissioning costs can be expected to be priced immediately resulting in a lower current stock price.

(because compound interest accrues exponentially) and the mismatch between expense and asset usage, i.e., the asset itself would be used uniformly over the life of the plant but the annual interest charge will increase over time since liability is measured at present value.

At this time, consistent with current utility practice, decommissioning costs are not fully recognized on the balance sheet. Still, estimates of current costs (i.e., what it would cost to decommission today) and decommissioning trust fund balances are disclosed in financial statement footnotes (Boatsman *et. al.,* 2000, p. 226). In addition, as discussed below, estimates of the present value of decommissioning costs (based on calculations of when a plant was placed in service and its estimated useful life) can be obtained based on the methodology discussed by Boatsman *et al.* (2000, p. 215). Also, the GAO (1999, p. 38) provides present value information about decommissioning costs based on alternative baseline (most likely), pessi-mistic, and optimistic scenarios. As discussed in the next section, we use footnote disclosures as well as these other data to assess whether investors are cognizant of unfunded decommissioning costs and whether these unfunded costs are priced by equity investors as equivalent to other utility liabilities.

3. METHODOLOGY, HYPOTHESES, AND DATA

To test whether unfunded decommissioning costs are priced in the equity market, we utilize a cross-sectional valuation model based on the balance sheet identity that has been used extensively in the prior literature (Barth, 1991, p. 438; Barth and McNichols, 1994, p. 193; Beaver *et al.,* 1989, p. 165).[9] This model relates the market value of common equity to the market value of assets and liabilities, and is described by the following equation:

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[9]Barth (1991, p. 437) points out that since "the model is asset and liability based, there is no explicit role for other factors such as future earnings or quality of management." Further, the model adopts the Modigliani and Miller (1958, p. 269) and Miller (1977, p. 266) view that the tax advantage of debt need not be incorporated (particularly for electric utilities since taxes are pass through costs paid for by ratepayers and not shareholders). As noted by Barth (1991, p. 437) this view "is consistent with FASB measures of assets and liabilities, which are recognized on a before-tax basis."

$$MVE = MVA - MVL$$

where MVE, MVA and MVL are the market values of common equity, total assets, and liabilities, respectively. In light of the non-observability of the market value of assets and liabilities, prior research has used book values as surrogates for market values.[10]

3.1 Basic model

For this study, we estimate the following basic model:

$$MVE = \beta_0 + \beta_1 BVA + \beta_2 BVL + \beta_3 U\_ + e \qquad (1)$$

where BVA is the book value of assets, BVL is the book value of liabilities, and U_ is the amount of unfunded nuclear decommissioning costs.[11] In a rate-regulated environment where the enterprise is expected to earn only a reasonable rate-of-return on its asset base, the expected coefficient values for BVA and BVL are +1 and -1, respectively. To correct for heteroscedasticity, all variables in model (1) are deflated by the number of common shares outstanding after adjusting for stock splits and stock dividends.[12]

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[10]The potential for estimation error in using book values of assets and liabilities as proxies for market values is considerably reduced for electric utilities since historically the industry has been rate-regulated and the rate-of-return regulatory environment can be expected to equate book values with market values over time. In this environment, any difference between book and market values is attributable to regulatory lag and is expected to be temporary (Myers, 1972, p. 85). Moreover, the industry is only now beginning to emerge from rate-regulation and the deregulation process is partial and incomplete at this time.

[11]For utilities that report decommissioning trust funds on their balance sheet, we subtract out the reported trust fund balances from total assets. Thus, BVA does *not* include decommissioning trust funds.

Also, as discussed previously in section 2.2, in current utility practice decommissioning costs are accrued each year as depreciation expense with the credit going either to accumulated depreciation or to a liability account. The accumulated provision for decommissioning, whether in accumulated depreciation or a liability account, is taken out of BVA or BVL as appropriate. Hence, in our model, decommissioning costs appear only in the variable U_.

[12]We also estimated model (1) in undeflated form and used White's (1980) consistent standard errors to correct for heteroskedasticity. The findings of such estimations are essentially identical to those reported in the paper using number of shares as the deflator (and thus not reported).

Variable U_ (unfunded decommissioning costs) is our test variable and is defined as decommissioning costs less decommissioning trust fund assets. Data on decommissioning trust fund assets were obtained from financial statements. As for decommissioning costs, we use alternative estimates based on (1) current cost, (2) methodology discussed by Boatsman *et. al.* (2000, p. 215), and (3) present value information provided by the GAO (1999, pp. 45-47) relating to baseline, pessimistic, and optimistic scenarios. Current cost data (i.e., estimates of what it would cost to decommission today) were obtained from financial statement footnotes. As noted previously, the FASB (2000, ¶ 15) exposure draft indicates that decommissioning obligations should be reported at their present value rather than at their current cost. Boatsman *et al.* (2000, p. 216) estimate present value by first compounding the current cost estimate to a future value in the approximate year of decommissioning using a 3 percent annual-average cost-escalation rate, and then discounting that future value back to the current year using the yield on the 30 year U.S. Treasury bond at the time the plant began operations. Finally, the GAO (1999, pp. 45-47) provides present value information about decommissioning costs based on alternative assumptions (baseline, pessimistic, and optimistic scenarios) about factors such as the cost-escalation rate and the expected operating life of the plant. We utilize the GAO (1999, pp. 45-47) data along with financial statement data about decommissioning trust funds to obtain baseline (i.e., most likely), pessimistic, and optimistic present value estimates of unfunded decommissioning costs.

Since the equity market is forward looking and the stock price is expected to incorporate an infinite time horizon (Jensen, 1986, p. 11), we hypothesize that uncertain future outcomes are appropriately priced by investors (stockholders) who represent the residual claimants in a firm. As noted previously, there are three conceivable future outcomes with regard to the recovery of unfunded decommissioning costs from ratepayers. First, the rate-regulators could permit full recovery from customers. In this outcome, the unfunded obligations would be fully paid for from additional revenues from customers; hence, the unfunded costs would *not* represent a claim against utility net assets and are *not* expected to be priced by investors. Corresponding to this first outcome (full recovery from ratepayers), our Hypothesis (stated in the null form) is as follows:

> H0: In model (1), the coefficient of the U_ variable is *not* different from zero.

Second, the rate-regulators could permit partial recovery of unfunded decommissioning costs from ratepayers in which case the remaining portion of the unfunded costs would represent a potential claim against utility net assets. In this second outcome, the unfunded obligation is expected to be priced by investors but only partially, i.e., a dollar of unfunded decommissioning costs is expected to have a smaller incremental negative effect on the stock price than a dollar of other liabilities. Corresponding to this second outcome (partial recovery from ratepayers), our Hypothesis (stated in the alternative form) is as follows:

> H1: In model (1), the coefficient of the U_ variable is negative and its absolute value is smaller than the absolute value of the coefficient for the BVL variable.

Finally, the rate-regulators could be unwilling or unable (particularly in the context of a deregulated competitive market for electricity) to permit any recovery at all from ratepayers, in which case all of the unfunded costs would represent a potential claim against utility net assets. In this third outcome, the unfunded obligations are expected to be priced by investors as equivalent to a liability. Corresponding to this third outcome (zero recovery from ratepayers), our Hypothesis (stated in the alternative form) is as follows:

> H2: In model (1), the coefficient of the U_ variable is negative and equal to the coefficient for the BVL variable.

3.2 Alternative model

In our alternative model 2, we focus on two utility-specific factors (regulatory environment and financial risk) that are likely to influence the recoverability of unfunded decommissioning costs.

$$MVE = \beta_0 + \beta_1 BVA + \beta_2 BVL + \beta_3 U\_ + \beta_4 U\_{*}D + e \qquad (2)$$

In model 2, the test variable is the interaction variable U_*D, where D is a dummy variable as discussed below.

3.2.1 Regulatory Environment

Traditionally, investors in utility companies have recognized the importance of the quality of regulation by state public utility commissions (PUCs). From an industry perspective, a favorable regulatory environment (climate) implies decisions that are protective of stockholder interests such as a shorter regulatory lag and authorization of a higher percentage of revenue increases requested by the utility companies (Davidson and Chandy, 1983, p. 52). As noted previously, even with deregulation a PUC that is favorably inclined towards the industry could impose exit fees or other tariffs on ratepayers during a transition period to recover stranded costs (Aggarwal, 1997, p. 104). Hence, the importance of the regulatory environment is expected to persist even after deregulation, and a utility company operating in a more favorable regulatory environment is more likely to be able to recover stranded costs. By the same token, a utility company operating in a more *un*favorable environment (i.e., an environment unfavorable to utility stockholders) is *less* likely to be able to recover unfunded decommissioning costs from ratepayers.

In the past, firms such as Duff & Phelps (1992, p. 12) have provided regulatory environment rankings typically on a 5 point scale, with 1 (5) indicating the most (least) favorable rating. To sharpen the contrast between a favorable and an unfavorable regulatory environment, we utilize these ratings to form the dummy variable D, where D=1 indicates an *un*favorable environment (rankings 4 and 5) and D=0 otherwise (rankings 1, 2, and 3). From an industry (stockholder) perspective, an *un*favorable regulatory environment increases the odds of outcomes 2 and 3 discussed previously, i.e., only partial or zero recovery of unfunded decommissioning costs from ratepayers. Stated in the alternative form, our Hypothesis is as follows:

> H3: In model (2), the coefficient of the interaction variable U_*D (where D=1 represents an *un*favorable regulatory environment, and D=0 otherwise) is negative.

3.2.2 Financial risk

In the context of deregulation, a lower cost utility is *ceteris paribus* more likely to be profitable and thus able to recover all of its costs (including unfunded decommissioning costs) from ratepayers at the market-determined competitive price for electricity. By contrast, a higher cost utility is less likely to be able to recover all of its costs (including decommissioning costs) in a competitive market-place without some kind of regulatory intervention or price support. Thus, a higher cost producer is at increased risk for outcomes 2 and 3, i.e., only partial or zero recovery of unfunded decommissioning costs.

As noted by Hyman (1994, p. 255), the electric utility industry is capital intensive (i.e., requires three to four dollars of plant investments to generate one dollar of revenue) and raises about half of its capital through senior debt. In 1993 (with deregulation looming on the horizon), the debt rating agencies raised their standards and began to incorporate cost factors and local competitive market conditions in assessing the financial risk of utility companies as measured by their bond ratings (Hyman, 1994, p. 324). Essentially, these bond ratings capture the financial competitiveness of a utility in a potentially deregulated marketplace. To sharpen the contrast between financially stronger and weaker utility companies, we utilize Moody's (1995, p. 3497) bond ratings for senior debt to form the dummy variable D, where D=1 indicates a financially riskier utility (i.e., a utility with a senior debt rating of BAA or below) and D=0 otherwise (a utility with a senior debt rating of A or above). We hypothesize that for a financially riskier utility (i.e., a utility that is at a potential disadvantage in a deregulated local marketplace due to higher costs), the odds of outcomes 2 and 3 (i.e., only partial or zero recovery of unfunded decommissioning costs) are higher. Stated in the alternative form, our Hypothesis is as follows:

> H4: In model (2), the coefficient of the interaction variable U_*D (where D=1 represents a financially riskier utility, and D=0 otherwise) is negative.

3.3 Sample and data

Our initial sample consisted of the 38 firms identified by Boatsman *et al*. (2000, p. 227). Boatsman *et al*. (2000, p. 227) identified all electric and electric/gas utility combinations on

Compustat in 1995 that had nuclear involvement and for which information about decommissioning current costs and the year of initial nuclear plant operation could be obtained. However, subsequent mergers among the utility firms and the unavailability of decommissioning trust fund data for some firms reduced our final sample to a total of 95 firm-year observations (32 firms in 1995 and 1996, and 31 firms in 1997).

All the firms in our sample had December 31 as their fiscal year-end. Hence, stock price data as of March 31 and accounting data as of December 31 were obtained from Compustat. Data on decommissioning trust fund assets and current costs were hand-collected from annual reports and/or 10-K filings from the Compact Disclosure database. The SEC's EDGAR database and the National Automated Accounting Retrieval System (NAARS) were used to supplement the annual reports and/or 10-K filings missing in the Compact Disclosure database.[13] Also, present value estimates of unfunded decommissioning costs were derived using the Boatsman *et al.* (2000, p. 215) algorithm and the trust fund data. Finally, we utilized the information in GAO (1999, pp. 45-47) to derive additional present value data relating to baseline (i.e., most likely), pessimistic, and optimistic estimates of unfunded decommissioning costs.

4. EMPIRICAL FINDINGS

4.1 Descriptive data

Table 1 provides descriptive data for our dependent and explanatory variables for the 1995-97 pooled sample. Consistent with Hyman (1994, p. 257), the data in panel A indicate that the electric utility industry is highly leveraged. The mean book value of assets (BVA) is $67.63 per share, and

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[13]Current cost estimates for decommissioning are based on the year of the site-specific cost study. To enhance the cross-sectional comparability of the reported estimates, the current cost data reported in the annual report and/or 10-K are converted to 1995-1997 fiscal year-end dollars using an adjustment factor. The adjustment factor is computed by dividing the implicit price deflator for private nonresidential structures at fiscal year-end by the similar price deflator for the year of the decommissioning cost study. Information on the implicit price deflators was obtained from Citibase (1994).

the mean book value of liabilities (BVL) is $44.79 per share. Thus, on average less than half (33.7%) of utility assets are financed through equity. Also, the mean unfunded decommissioning current cost (U_CC) is $3.77 per share. Recall that (1) current costs are estimates of what it would cost to decommission the nuclear power plant today (the balance sheet date), (2) unfunded decommissioning costs are computed by subtracting the amount of decommissioning trust fund assets from cost estimates, and (3) data for both decommissioning trust fund assets and current costs were obtained from financial statement footnotes. On average, unfunded decommissioning current costs ($3.77 per share) are about 16.5% of utility net assets (BVA - BVL = $67.63 - $44.79 = $22.84 per share). Thus, on average unfunded decommissioning current costs potentially represent a material claim on stockholders equity.

Our second estimate of unfunded decommissioning costs (U_BO) is obtained by subtracting the amount of decommissioning trust fund assets from the *present value* of decommissioning current costs. The present value is obtained using the Boatsman *et al.* (2000, p. 216) methodology, which (as discussed previously) takes into account the remaining useful life of the plant and assumes (1) an annual cost-escalation rate of 3%, and (2) a discount rate equal to the yield on the U.S. Treasury 30-year bond at the time the plant was placed in service. Given the time value of money, the present value estimate can be expected to be smaller than the current cost estimate. Thus, in Table 1 the mean value of U_BO ($0.35 per share) is lower than the mean value of U_CC ($3.77 per share, as discussed previously). Based on the Boatsman *et al.* (2000, p. 216) methodology, unfunded decommissioning costs represent a much less consequential potential obligation (only about 1.5% of utility net assets).

Our three remaining estimates of unfunded decommissioning costs (U_BASE, U_PESS, and U_OPTI) are also obtained by subtracting the amount of decommissioning trust fund assets from *present value* estimates of decommissioning costs. As discussed previously, these present value estimates are based on a GAO (1999, p. 38) study which notes that "an analysis of possible conditions tens of years into the future is inherently uncertain." The GAO (1999, p. 38) analysis assigns likely values to factors such as the expected operating life of the plant, the cost-escalation rate, and the discount rate (which is treated as being equal to the expected rate of return on decommissioning trust fund assets), to obtain the baseline (most likely) estimate of decommissioning costs. In contrast to the baseline estimate, the pessimistic and optimistic estimates reflect the bounds of unfavorable and favorable conditions that the utility might face. The GAO (1999, p. 39) notes that "because all of the assumptions are pessimistic for the pessimistic scenario and optimistic for the optimistic scenario, (the) results for each of these two scenarios can be considered as extreme in both the pessimistic and optimistic directions, respectively."

In Table 1 (panel A), the mean baseline (most likely) present value estimate of unfunded decommissioning costs (U_BASE) is $1.94 per share which is equal to 8.5% of utility net assets ($22.84 per share, as noted previously). By contrast, the mean pessimistic (U_PESS) and the mean optimistic (U_OPTI) present value estimates of unfunded decommissioning costs are $9.88 and $0.73 per share, respectively. As a percentage of utility net worth ($22.84 per share), the pessimistic and optimistic estimates are 43% and 3% of stockholders equity, respectively.

Given the time value of money, the mean present value estimates of unfunded decommissioning costs are generally lower in magnitude than the mean current cost estimate, i.e., the mean values per share of U_BO ($0.35), U_BASE ($1.94), and U_OPTI ($0.73) are all less than the mean value per share of U_CC ($3.77). Also, on average, the baseline estimate (U_BASE: $1.94 per share) and the current cost estimate (U_CC: $3.77 per share) fall within the upper and lower bounds of unfavorable and favorable conditions represented by the pessimistic and optimistic estimates ($9.88 and $0.73 per share, respectively). However, the mean estimate based on the Boatsman *et al.* (2000, p. 215) methodology (U_BO: $0.35 per share) falls *below* the lower bound represented by the optimistic estimate (U_OPTI: $0.73), suggesting that the U_BO estimate may be very conservative and therefore perhaps not as valid or reliable as the other estimates. Still, using 1% of net assets as an arbitrary materiality threshold, all the different estimates suggest that on average unfunded decommissioning costs potentially represent a material claim on stockholders equity. Also, panel A suggests considerable variation in the magnitude of these estimates across utility firms. Finally, panel B indicates that all the different estimates of unfunded decommissioning costs are positively correlated with each other suggesting that they all measure similar constructs.

4.2 Regression results

4.2.1 Basic model

Table 2 (panel A) presents the ordinary least squares (OLS) regression results for the pooled sample.[14] Consistent with the prior literature, the book value of assets (BVA) and the book value of liabilities (BVL) are important in determining the market value of the firm; both variables are significant with the anticipated signs. In particular, a higher book value of assets (BVA) is associated with a *higher* equity value, and a higher book value of liabilities is associated with a *lower* equity value for the firm. As discussed previously, the expected coefficient values for BVA and BVL are +1 and -1, respectively. In Table 2 (panel A), the null hypothesis that the coefficients for BVA and BVL are equal to +1 and -1, respectively, could *not* be rejected at the .10 level.

The focus of our study is the unfunded decommissioning cost (U_) variables. In Table 2 (panel A), four of the five alternative estimates of unfunded decommissioning costs are statistically significant with the anticipated negative sign. Since collinearity may inflate the standard error and render an explanatory variable (such as U_BO) insignificant according to the t-test, we used a

[14]The equations in Tables 2 through 4 were tested for the requirements underlying ordinary least squares (OLS) regression, i.e., normality of residuals and homoscedasticity. The null hypothesis that these requirements are met could not be rejected at the .10 level (one-tail test). Hence, the assumption of an underlying linear relationship appears to be valid for our data. Also, for each of the regressions, we evaluated the sensitivity of our findings to influential observations by calculating the studentized residual for each observation (Belsley *et al.* 1980, p. 20), eliminating observations with studentized residuals in excess of the absolute value of two, and re-estimating the regressions. The findings of these alternative analyses were similar to those discussed in the paper indicating that our results were not being affected by influential outliers.

heuristic known as the variance inflation factor (VIF) to test for collinearity.[15] According to Neter *et al.* (1996, p. 387), a VIF of 10 or higher is indicative of a collinearity problem. In Table 2 (panel A), the *highest* VIF for any unfunded decommissioning cost variable was only 1.36 (for U_BASE) and the VIF for U_BO was only 1.05. Hence, the lack of significance for the U_BO variable *cannot* be attributed to collinearity. Rather, its lack of significance may be due to the notion (discussed previously) that decommissioning cost estimates based on the Boatsman *et al.* (2000, p. 215) methodology may be very conservative. Overall, the results from Table 2 (panel A) suggest that investors are cognizant of decommissioning costs and price these unfunded obligations as a potential claim on utility net assets.[16]

As noted previously, we were unable to reject the null that the coefficient of BVL (the book value of liabilities) is equal to -1. In Table 2 (panel A), the coefficients of the alternative unfunded decommissioning cost variables are generally smaller (in absolute terms) than the coefficient for BVL. The one exception is the optimistic estimate (U_OPTI) which (as noted previously) reflects the bounds of favorable conditions and reports a low mean unfunded cost estimate of $0.73 per share. Apparently, the market compensates for the optimistic assumptions underlying this *low* estimate by assigning a *high* absolute weight/coefficient of 1.04 to the U_OPTI variable. Similarly, the

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[15]The VIF measures the interrelationship among the explanatory variables. It is calculated for each explanatory variable and is equal to 1/(1 - Rsquare), where the Rsquare is obtained by regressing that explanatory variable on all the other explanatory variables.

[16]As suggested by a reviewer, we also estimated model (1) in first difference form and found that the coefficients on the change in BVA and the change in BVL were statistically insignificant although the coefficient on the change in unfunded decommissioning cost variable was significant ($p<0.10$, one-tail test). The lack of significance for the change in BVA and change in BVL variables raises concerns about the efficacy of the first difference approach in addressing any correlated omitted variable bias. In this context, Landsman and Magliolo (1988, p. 602) have questioned the benefit of estimating a first-difference version of a valuation model.

Also, as suggested by the reviewer, we included current earnings as an explanatory variable in model 1. As noted previously, the industry is only now emerging from rate-regulation where it was expected to earn only a reasonable rate of return. By definition, there are no abnormal earnings in a rate-regulated context. Hence, as one would expect, the earnings variable was not significant.

pessimistic estimate (U_PESS) reflects the bounds of *un*favorable conditions and reports a high mean unfunded cost estimate of $9.88 per share. Apparently, the market compensates for the pessimistic assumptions underlying this *high* estimate by assigning a *low* absolute weight/coefficient of only 0.15 to the U_PESS variable.

A smaller coefficient (in absolute terms) for the unfunded cost U_ variables (relative to the coefficient for the BVL variable) suggests that a dollar of unfunded decommissioning costs has a smaller incremental negative effect on firm value than a dollar of other liabilities. The null hypothesis that the coefficients of U_CC, U_BASE, and U_OPTI are each equal to the coefficient of the BVL variable could *not* be rejected at the .10 level using one-tailed t-tests, although this could be due to limited degrees of freedom as a result of small sample size. However, the null hypothesis that the coefficient of the pessimistic unfunded decommissioning cost estimate U_PESS is equal to the coefficient of BVL was rejected at the .01 level using a one-tailed t-test. Overall, the results appear to suggest that the coefficients for the unfunded decommissioning cost variables may be smaller than the coefficient for BVL; thus, dollar-for-dollar unfunded decommissioning costs appear to have a smaller incremental negative effect on the price per share than do other utility liabilities.[17]

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[17]A reviewer indicated that it might be useful to (a) compare the coefficient on the recognized (recorded) decommissioning liabilities and the *un*recognized unfunded decommissioning liabilities (i.e., the decomposed *un*recognized component of U_), and (b) provide a descriptive statistic of the proportion of the U_ that is recognized.

As noted previously, approximately two-thirds (22) of our sample firms credited accumulated depreciation while the rest (10) credited a liability account. We initially focused our analysis on the 10 firms that credited a liability account.

It seemed to us that if investors sought to price the recorded (recognized) decommissioning liability, they would also be interested in the amount available in the external decommissioning trust funds to pay for this liability. In other words, investors are likely to price the unfunded recorded decommissioning liability rather than the recorded liability itself. As noted previously, our book value of assets variable (BVA) does *not* include decommissioning trust funds.

Thus, in our additional analysis we treated (1) the unfunded recorded decommissioning liability and (2) the *un*recorded unfunded decommissioning liability (i.e., the decomposed *un*recognized component of U_) as separate variables. As an example, if a firm had $10 of recorded decommissioning liability, $8 of external decommissioning trust funds, and $40 of U_, the unfunded recorded liability would be $2 (=$10 minus $8) and the *un*recognized component

Table 2 (panel B) presents the year-by-year regressions for the basic model.[18] As in panel A, the explanatory variables (BVA, BVL, and U_) have the predicted signs. As before, the null hypothesis that the coefficients for BVA (book value of assets) and BVL (book value of liabilities) are equal to +1 and -1, respectively, could *not* be rejected at the .10 level. In panel B, the unfunded

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would be $38 (= $40 minus $2).

As discussed previously, in current practice the obligation to decommission a nuclear plant is treated as a cost of providing service and is accrued over the economic life of the plant. Thus, over the life of the plant, additional depreciation expense is recorded each year with the offsetting credit going either to accumulated depreciation or to a liability account. In a rate-regulated environment, the additional depreciation expense permits the utility to collect additional revenues from customers which are then invested (in compliance with NRC regulations) in external trust funds to accumulate resources for decommissioning (GAO, 1999, p.13).

Consequently, as one would expect, for our sample firms the trust fund amounts on average were quite close to the amount of the recorded decommissioning liability. For the 10 firms that credit a liability, there were 29 firm-year observations. The mean unfunded recorded liability was $0.09 per share and the median was $0.00 per share. As one might expect, in the regressions the unfunded recorded liability was not significant while the *un*recognized decommissioning liability (i.e., the decomposed *un*recognized component of U_) was significant with a negative sign.

In expanded analysis (to increase the sample size), we treated the amount credited to accumulated depreciation as a credit to a liability account although the FASB (1996,¶ 43 and 97) suggests that investors do *not* recognize the amount credited to accumulated depreciation as a liability. Of the 95 firm-year observations in our sample, 24 observations had trust fund amounts equal to the amount of the recorded decommissioning liability. The mean and median amount of unfunded recorded decommissioning liability for the 95 observations was $0.10 and $0.00 per share, respectively. Based on the mean values for U_ reported in Table 1 (panel A), the recognized proportion of U_ is 2.7% ($0.10/$3.77) for U_CC, 28.6% for U_BO, 5.2% for U_BASE, 1.0% of U_PESS, and 13.7% of U_OPTI. Thus, on average, only a small proportion of the unfunded decommissioning liabilities (U_) are currently reported in the financial statements indicating a significant gap in recognition.

As one might expect (given the small magnitude of the unfunded recorded liability), in regression analysis the unfunded recognized liability was *not* significant although the *un*recognized decommissioning liability (i.e., the decomposed *un*recognized component of U_) was significant with a negative sign consistent with the results reported for U_ in Table 2.

[18]In panel B, the intercept term (in most cases) is significantly greater than zero, a finding consistent with prior research, e.g., Beaver *et al.* (1989, p. 170) and Shevlin (1991, p. 14). Shevlin (1991, p. 14) suggests that a positive intercept is consistent with an excess of nonreported assets over nonreported liabilities that are independent of the reported assets and liabilities, and that the results should be viewed with caution. Consistent with Shevlin (1991, p. 15), in this study we probe the robustness of the results on the test variable U_ by examining (1) five different alternative estimates of unfunded decommissioning costs, and (2) the interaction between the alternative estimates of unfunded decommissioning costs and the regulatory climate and financial risk.

de-commissioning cost variables (U_) are generally significant in the 1996 regression, and U_BASE (the baseline present value estimate) is significant in the 1995 regression. The highest VIF for any unfunded decommissioning cost variable (U_) in panel B was only 1.49; hence, the lack of significance of the U_ variables in the 1997 regression cannot be attributed to collinearity. Once again, the present value estimate based on the Boatsman *et al* (2000, p. 215) methodology (variable U_BO) is not significant in any year.

In panel B of Table 2, as in panel A, the coefficients of the alternative unfunded decommissioning cost U_ variables are generally smaller (in absolute terms) than the coefficient for BVL. As in panel A, the null hypothesis that the coefficient of the pessimistic estimate U_PESS is equal to the coefficient of BVL was rejected at the .01 level using a one-tailed t-test. However, the null hypothesis that the coefficients of the other U_ variables, where significant, are each equal to the coefficient of variable BVL could *not* be rejected at the .10 level using one-tailed t-tests, although this could be due to limited degrees of freedom as a result of small sample size. Overall, the results from panel B (although relatively weak) suggest that market is cognizant of unfunded decommissioning costs, and that dollar-for-dollar these unfunded obligations have a smaller incremental negative effect on the price per share than other utility liabilities.

4.2.2 Alternative model

The alternative model focuses on two utility-specific factors (regulatory environment and financial risk) that are likely to influence the recoverability of unfunded decommissioning costs from ratepayers. In this model, the test variable is the interaction variable U_*D, where D is a dummy variable indicating either an *un*favorable regulatory environment (in Table 3) or greater financial risk (in Table 4).[19] In both Tables 3 and 4, as one might expect, there is collinearity between the main

[19]In our sample, 51 firm-year observations operated in an *un*favorable regulatory environment and 27 firm-year observations had a Moody's (1995, p. 3497) senior debt rating of BAA or below.

unfunded decommissioning cost variable (U_) and the test interaction variable (U_*D). Specifically, the spearman correlations between U_ and U_*D ranged from 0.15 to 0.76 in Table 3 (panels A and B) and from 0.29 to 0.89 in Table 4 (panels A and B).

Table 3 (panels A and B) presents the results for the pooled regression and the year-by-year regressions for the alternative model, where the dummy variable D is = 1 for an *un*favorable regulatory environment, and is = 0 otherwise. In both panels, BVA (the book value of assets) and BVL (the book value of liabilities) are significant with the anticipated signs. The null hypothesis that the coefficients for BVA and BVL are equal to +1 and -1, respectively, could *not* be rejected at the .10 level in either panel.

As discussed previously, an *un*favorable regulatory environment increases the odds of only partial recovery or no recovery at all (zero recovery) of decommissioning costs from customers in the form of higher electricity rates. Thus, for utilities operating in an *un*favorable regulatory climate, unfunded decommissioning costs are more likely to be viewed by investors as an increase in utility obligations and a decrease in utility net assets (stockholders equity).

In Table 3 panel A, none of the main unfunded decommissioning cost (U_) variables are significant although the interaction test variables (with the exception of U_OPTI*D) are significant with the anticipated negative sign.[20] In particular, the t-statistic (and the associated significance level) for each of significant interaction variables is higher in panel A of Table 3 than in panel A of Table 2. Also, in absolute terms, the coefficient values of the test variables in panel A of Table 3 are greater than the corresponding coefficient values in panel A of Table 2. Still, the null hypotheses that the coefficients of U_CC*D, U_BO*D, and U_BASE*D are each equal to the coefficient of the BVL

[20]The lack of significance for U_OPTI*D in both panels A and B may be attributed to collinearity. Specifically, in panel A, the VIFs for U_OPTI and U_OPTI*D were 19.7 and 19.5, respectively. An incremental one-tailed F-test (F = 2.54, p<0.10) indicated that the main and interaction variables together add significant explanatory power although they are not individually significant in the regressions.

variable could *not* be rejected at the .10 level using a one-tailed t-tests. However, the null hypothesis that the coefficient of U_PESS*D is equal to the coefficient of BVL was rejected at the .10 level using a one-tailed t-test. As discussed previously, apparently the market compensates for the pessimistic assumptions underlying the *high* pessimistic estimate by assigning a *low* absolute weight of only 0.58 to the U_PESS*D variable. Similar results are indicated in panel B (Table 3), where the test variables (except for U_OPTI*D) are generally significant with an anticipated negative sign. In the OLS regressions with U_CC and U_CC*D as the explanatory variables, the coefficient of U_CC is significant with an unexpected positive sign in 1996 and 1997, although the net coefficient (i.e., the sum of the coefficients of U_CC and U_CC*D) is negative in each of those years. Overall, the results reported in Table 3 are stronger than those reported in Table 2, and suggest that investor pricing of unfunded decommissioning costs is influenced by the regulatory climate in that a dollar of unfunded costs has a greater incremental negative effect on firm value for a utility operating in an *un*favorable regulatory environment.

Finally, Table 4 (panels A and B) presents the results for the pooled regression and the year-by-year regressions for the alternative model, where the dummy variable D is = 1 for a financially riskier utility (i.e., a utility with a Moody's (1995, p. 3497) bond rating of BAA or below), and is = 0 otherwise. In both panels A and B, BVA (the book value of assets) and BVL (the book value of liabilities) are significant with the anticipated signs, and the null hypothesis that the coefficients for BVA and BVL are equal to +1 and -1, respectively, could *not* be rejected at the .10 level using one-tailed t-tests.[21]

As discussed previously, Hyman (1994, p. 324) indicates that since 1993 the rating agencies have attempted to incorporate cost factors and local competitive market conditions in assessing the

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[21]In panel B, BVL is not significant in 1995 in regressions with U_CC or U_PESS as explanatory variables. In both cases, the lack of significance of BVL may be attributed to collinearity.

financial risk of utility companies as measured by their bond ratings. In the context of deregulation, a higher cost utility operating in a more competitive local environment is less likely to be able to recover all of its costs (including decommissioning costs) at the competitive market price for electricity. Thus, investors might perceive a utility with a lower bond rating as being at greater risk of only partial recovery or no recovery at all (zero recovery) of decommissioning costs from customers. Hence, investors in financially riskier utilities are more likely to view unfunded decommissioning costs as an increase in utility obligations and a decrease in utility net assets (stockholders equity).

In panel A, none of the main unfunded decommissioning cost (U_) variables are significant although the interaction test variables U_CC*D and U_PESS*D are significant with the anticipated negative signs.[22] In general, the t-statistics (and the associated significance levels) for these variables are higher in panel A of Table 4 than in panel A of Table 2. Once again, the null hypothesis that the coefficients of U_CC*D and U_PESS*D are each equal to the coefficient of the BVL variable could *not* be rejected at the .10 level using one-tailed t-tests. Similar results are indicated in panel B of Table 4, where the test variables U_CC*D and U_PESS*D are significant in both 1995 and 1996. Overall, the results reported in Table 4 (although not quite as strong as those reported in Table 3) are somewhat stronger than those reported in Table 2. These findings suggest that investor pricing of unfunded decommissioning costs is influenced by financial risk in that a dollar of unfunded costs has a greater incremental negative effect on firm value for a utility that is perceived to be financially

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[22]Once again, the lack of significance of the interaction variables U_BASE*D and U_OPTI*D (in both panels A and B) may be attributed to collinearity with the main variable U_BASE and U_OPTI, respectively. Specifically, in panel A, these main and interaction variables had VIFs of 13 or higher. Also, the incremental one-tailed F-test was significant ($p<0.10$) indicating that the main and interaction variables (e.g., U_BASE and U_BASE*D) together add significant explanatory power although they are not individually significant in the regressions.

riskier.[23]

5. CONCLUDING REMARKS

In this study, we provide some evidence that investors in electric utilities are cognizant of unfunded nuclear decommissioning costs. However, these potential obligations appear to be priced as if investors expect partial recovery of unfunded decommissioning costs from ratepayers. In absolute terms, the coefficients for the unfunded decommissioning cost variables were generally smaller than the coefficient for the variable representing other liabilities. Thus, unfunded decommissioning costs and the utility's other liabilities appear to have dissimilar effects on the share price; dollar-for-dollar, unfunded decommissioning obligations seem to have a smaller incremental negative effect on firm value than do other liabilities.

Our tests were based on current costs (i.e., what it would cost to decommission the nuclear plant today as disclosed in financial statement footnotes) as well as present value estimates of decommissioning costs. The FASB (2000, ¶ 15) exposure draft indicates that the liability for decommissioning should be measured at its present value at the time of initial plant operation. Still, as noted by the GAO (1999, p. 12), present value estimates of nuclear decommissioning costs are inherently uncertain since they are based on an analysis of possible conditions tens of years into the

[23]Since the main variable U_ was not significant in Tables 3 and 4 (panel A), in additional analysis we dropped variable U_ from model 2. The potential benefit from this specification is that it avoids the confounding effects of collinearity between the main U_ variable and the interaction test variable U_*D in interpreting the results. For Table 3, the results from this additional analysis indicated that all of the interaction variables U_*D were significant with the anticipated negative sign. The absolute values of the coefficients ranged from 0.27 (for U_PESS*D) to 1.26 (for U_CC*D). The null hypothesis that the coefficients for each of the significant test variables (except the pessimistic estimate U_PESS*D) is equal to the coefficient for BVL could not be rejected at the 0.10 level using one-tailed t-tests. For Table 4, the results of the additional analysis indicated that all of the test variables (except U_BO*D) were significant with a negative sign. The absolute values of the coefficients ranged from 0.21 (for U_PESS*D) to 0.97 (for U_CC*D). The null hypothesis that the coefficients for each of the significant test variables (except the pessimistic estimate U_PESS*D) is equal to the coefficient for BVL could not be rejected at the 0.10 level using one-tailed t-tests. Other details of the additional analysis are available on request from the authors.

future. In our analysis, we used present value estimates of decommissioning costs based on the Boatsman *et al.* (2000, p. 215) methodology as well as the baseline (most likely), pessimistic, and optimistic present value estimates provided by the GAO (1999, pp. 45-47).

In a strictly rate-regulated environment, unfunded decommissioning costs would be of little concern to investors since these costs would normally be recovered from ratepayers as part of the overall cost-based regulated price for electricity. However, in the context of unfolding deregulation, there is significant uncertainty as to how much of these costs can in fact be recovered from ratepayers in a competitive market for electricity and how much of these unfunded costs eventually will have to be paid for from utility net assets. In our analysis, we attempted to control for two factors – regulatory environment and financial risk – that are likely to influence recovery from ratepayers. Our results suggest that investor pricing of unfunded decommissioning costs is influenced by the regulatory climate and financial risk, i.e., a dollar of unfunded decommissioning costs appears to have a greater incremental negative effect on the stock price of a utility operating in an *un*favorable regulatory environment or rated by Moody's (1995, p. 3497) as financially riskier.

Given the uncertainty inherent in present value estimates and the uncertainty associated with the future recoverability of unfunded decommissioning costs from ratepayers in the context of unfolding deregulation, a single present value estimate of decommissioning costs (as proposed by the FASB, 2000, ¶ 19) may not provide adequate disclosure for investors. Additional disclosures in the financial statements relating to the nature and future outcomes of nuclear power plant operations over a relevant (albeit extended) time period may help mitigate investor uncertainty and facilitate investor assessment of the magnitude and recoverability of unfunded decommissioning costs.

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Table 1
Descriptive Statistics and Correlations[a]

Panel A: Descriptive Statistics

Variable	n	Mean	Std. Dev.	Median	Minimum	Maximum
PRICE 95	$ 31.37	$10.01	$ 30.12	$ 6.62	$ 64.25	
BVA	95	67.63	18.98	65.56	20.83	108.60
BVL	95	44.79	14.75	41.60	13.34	78.92
U_CC	95	3.77	2.46	3.11	-0.00	12.73
U_BO 95	0.35	1.19	0.05	-1.88	4.30	
U_BASE	95	1.94	2.98	1.40	-0.20	19.56
U_PESS	95	9.88	9.67	6.91	0.93	61.76
U_OPTI	95	0.73	1.81	0.47	-0.75	11.52

Panel B: Spearman Correlations Among Alternative Estimates of Unfunded Decommissioning Costs

Variable	U_CC	U_BO	U_BASE	U_PESS	U_OPTI
U_CC	1.00				
U_BO	0.63	1.00			
U_BASE	0.59	0.41	1.00		
U_PESS	0.62	0.22	0.60	1.00	
U_OPTI	0.47	0.41	0.78	0.35	1.00

[a]All variables are in per share amounts.
[a]All correlations are significant at the 0.01 level (two-tailed).

PRICE = Common stock price per share.
BVA = Book value of assets per share.
BVL = Book value of liabilities per share.
U_CC = Unfunded decommissioning costs per share: current costs.
U_BO = Unfunded decommissioning costs per share: present value based on Boatsman *et al*. (2000).
U_BASE = Unfunded decommissioning costs per share: present value based on GAO (1999, pp. 45-47) baseline estimate.
U_PESS = Unfunded decommissioning costs per share: present value based on GAO (1999, pp. 45-47) pessimistic estimate.
U_OPTI = Unfunded decommissioning costs per share: present value based on GAO (1999, pp. 45-47) optimistic estimate.

Table 2

Panel A: Pooled Regression Results[a]

Basic (Fixed Effects) Model: $MVE = \beta_0 + \beta_1 BVA + \beta_2 BVL + \beta_3 U\_ + e$ (1)

BVA	BVL	U_CC	U_BO	U_BASE	U_PESS	U_OPTI	F-value	Adj R^2
1.02 (4.59)***	-1.09 (-3.85)***	-0.61 (-1.58)*					10.98***	0.35
0.96 (2.65)***	-1.05 (-2.25)**		-0.49 (-0.68)				10.33***	0.33
0.90 (4.08)***	-0.91 (-3.16)***			-0.71 (-2.19)**			11.70***	0.36
0.94 (4.27)***	-0.99 (-3.43)***				-0.15 (-1.55)*		10.94***	0.35
0.91 (4.10)***	-0.94 (-3.22)***					-1.04 (-1.98)**	11.42***	0.36

[a] The pooled regression (n=95) is for 1995, 1996, and 1997. The intercepts for the fixed effects model are not reported.

*, **, *** Significant at the 0.10, 0.05, and 0.01 level (all one-tailed), respectively.

Table 2 (Continued)

Panel B: Year-by-year Regression Results[a]

Basic Model: $MVE = \beta_0 + \beta_1 BVA + \beta_2 BVL + \beta_3 U\_\_ + e$ (1)

Year	Intercept	BVA	BVL	U_CC	U_BO	U_BASE	U_PESS	U_OPTI	F-value	Adj R^2
1995	10.96 (1.74)***	1.12 (2.73)***	-1.24 (-2.33)***	-0.38 (-0.52)					3.31**	0.18
1996	12.48 (2.18)**	0.96 (2.65)***	-1.05 (-2.25)**	-0.84 (-1.29)*					3.06**	0.16
1997	17.25 (2.32)**	1.06 (2.65)***	-1.10 (-2.06)**	-0.52 (-0.80)					2.92*	0.16
1995	11.57 (1.80)*	1.06 (2.45)***	-1.20 (-2.12)**		-0.39 (-0.29)				3.22**	0.17
1996	13.59 (2.32)**	0.82 (2.23)**	-0.93 (-1.92)**		-0.38 (-0.32)				2.41*	0.12
1997	17.32 (2.31)**	1.02 (2.38)***	-1.10 (-2.03)**		-0.58 (-0.42)				2.72*	0.15
1995	9.62 (1.59)	1.01 (2.53)***	-1.05 (-1.94)**			-0.87 (-1.33)*			3.97***	0.22
1996	10.64 (1.91)*	0.81 (2.42)***	-0.80 (-1.79)**			-1.11 (-2.21)**			4.25***	0.24
1997	17.21 (2.31)**	1.02 (2.38)***	-1.10 (-2.03)**			-0.32 (-0.58)			2.79*	0.15
1995	10.45 (1.66)*	1.08 (2.67)***	-1.16 (-2.16)**				–0.19 (-0.93)		3.58**	0.19
1996	11.91 (2.08)**	0.88 (2.55)***	-0.94 (-2.05)**				-0.23 (-1.43)**		3.23**	0.17
1997	17.45 (2.32)**	0.99 (2.23)**	-1.03 (-1.81)**				-0.07 (-0.42)		2.72*	0.15
1995	0.36 (1.48)	1.02 (2.55)***	-1.08 (-1.99)**					-1.31 (-1.26)	3.84***	0.21
1996	10.35 (1.83)***	0.81 (2.38)***	-0.81 (-1.79)**					-1.70 (-2.02)**	4.07***	0.23
1997	17.06 (2.27)**	0.99 (2.23)**	-1.03 (-1.82)**					-0.37 (-0.40)	2.71*	0.14

[a] For 1995, 1996, and 1997, n = 32, 32, and 31, respectively.

*, **, *** Significant at the 0.10, 0.05, and 0.01 level (all one-tailed except for intercept), respectively.

Table 3

Panel A: Pooled Regression Results[a]

Alternative (Fixed Effects) Model: $MVE = \beta_0 + \beta_1 BVA + \beta_2 BVL + \beta_3 U\_ + \beta_4 U\_ {*} D + e$ (2)

BVA	BVL	U_CC	U_CC*D	U_BO	U_BO*D	U_BASE	U_BASE*D	U_PESS	U_PESS*D	U_OPTI	U_OPTI*D	F-value	Adj R^2
0.74 (3.72)***	-0.70 (-2.70)***	1.81 (1.22)	-2.42 (-5.39)***									16.90***	0.50
0.95 (4.25)***	-1.04 (-3.61)***			1.84 (1.01)	-3.07 (-1.78)**							9.35***	0.35
0.88 (4.06)***	-0.85 (-2.97)***					2.17 (1.13)	-2.89 (-2.23)**					11.02***	0.39
0.78 (3.60)***	-0.73 (-2.56)***							0.37 (1.19)	-0.58 (-3.37)***			11.91***	0.41
0.92 (4.14)***	-0.92 (-4.14)***									0.71 (0.35)	-1.81 (-0.89)	9.63***	0.39

[a] The pooled regression (n=95) is for 1995, 1996, and 1997. The intercepts for the fixed effects model are not reported. Also, the dummy variable D is =1 for an *un*favorable regulatory environment (Duff & Phelps' rankings of 4 and 5), and = 0 otherwise.

*, **, *** Significant at the 0.10, 0.05, and 0.01 level (all one-tailed), respectively.

Table 3 (Continued)

Panel B: Year-by-year Regression Results[a]

Alternative (Fixed Effects) Model: $MVE = \beta_0 + \beta_1 BVA + \beta_2 BVL + \beta_3 U\_ + \beta_4 U\_*D + e$ (2)

YEAR	Intercept	BVA	BVL	U_CC	U_CC*D	U_BO	U_BO*D	U_BASE	U_BASE*D	U_PESS	U_PESS*D	U_OPTI	U_OPTI*D	F-value	Adj R^2
1995	8.62 (1.65)	0.66 (1.88)**	-0.56 (-1.29)**	2.22 (0.25)	-2.75 (-3.89)***									7.54***	0.46
1996	10.68 (2.14)**	0.63 (2.65)***	-0.57 (-1.93)**	1.39 (1.34)*	-2.22 (-3.16)***									5.54***	0.37
1997	14.84 (2.11)**	0.94 (2.31)***	-0.93 (-1.84)**	1.89 (1.46)*	-2.36 (-2.23)**									3.76***	0.27
1995	11.72 (1.91)*	1.01 (2.46)***	-1.11 (-2.04)**			4.88 (0.60)	-6.28 (-1.91)**							3.56**	0.24
1996	14.06 (2.43)**	0.82 (2.26)**	-0.92 (-1.93)**			2.63 (1.07)	-3.96 (-1.41)*							2.37**	0.15
1997	17.38 (2.27)**	1.03 (2.34)**	-1.11 (-2.00)**			-0.24 (-0.09)	-0.49 (-0.15)							1.97	0.11
1995	7.31 (1.12)	0.95 (2.37)***	-0.93 (-1.69)**					1.71 (0.74)	-2.67 (-1.17)					3.36**	0.23
1996	8.27 (1.43)	0.77 (2.34)**	-0.72 (-1.62)*					1.64 (0.77)	-2.77 (-1.34)*					3.74**	0.26
1997	14.01 (1.79)	0.99 (2.27)**	-0.99 (-1.77)**					2.96 (1.10)	-3.28 (-1.28)*					2.53*	0.16
1995	8.10 (1.39)	0.64 (1.59)*	-0.48 (-1.86)**							0.61 (1.26)	-0.93 (-2.53)*			4.81*	0.33
1996	10.21 (1.88)*	0.61 (1.73)**	-0.51 (-1.08)							0.34 (1.11)	-0.64 (-2.19)**			3.95**	0.27
1997	17.62 (2.07)*	0.97 (2.23)**	-1.00 (-1.78)**							0.32 (0.92)	-0.41 (-1.29)*			2.51*	0.17
1995	9.01 (1.38)	1.02 (2.51)***	-1.07 (-1.95)*									0.01 (0.003)	-1.39 (-0.36)	2.86*	0.04
1996	9.67 (1.67)	0.82 (2.42)**	-0.83 (-1.82)**									0.86 (0.26)	-2.65 (-0.80)	3.17	0.21
1997	16.83 (2.20)**	1.00 (2.21)**	-1.05 (-1.81)**									0.95 (0.25)	-1.37 (-0.36)	2.00*	0.12

[a] In this Table, the dummy variable D is =1 for an *un*favorable regulatory environment (Duff & Phelps' rankings of 4 and 5), and = 0 otherwise. For 1995, 1996, and 1997, n = 32, 32, and 31, respectively. *, **, *** Significant at the 0.10, 0.05, and 0.01 level (one-tailed except for intercept), respectively.

Table 4

Panel A: Pooled Regression Results[a]

Alternative (Fixed Effects) Model: $MVE = \beta_0 + \beta_1 BVA + \beta_2 BVL + \beta_3 U\_ + \beta_4 U\_*D + e$ (2)

BVA	BVL	U_CC	U_CC*D	U_BO	U_BO*D	U_BASE	U_BASE*D	U_PESS	U_PESS*D	U_OPTI	U_OPTI*D	F-value	Adj R^2
0.77 (3.32)***	-0.75 (-2.54)***	0.45 (0.87)	-1.23 (-2.92)***									11.35***	0.39
0.94 (4.14)***	-1.04 (3.51)***			-0.26 (-.022)	-0.37 (-0.25)							8.53***	0.32
0.89 (4.01)***	-0.91 (-3.11)***					-0.52 (-0.19)	-0.18 (-0.19)					9.65***	0.36
0.82 (3.62)***	-0.83 (-2.78)***							0.12 (0.70)	-0.30 (-1.91)**			9.99***	0.36
0.91 (4.07)***	-0.94 (-3.19)***									-1.02 (-0.53)	-0.02 (-0.01)	9.41***	0.35

[a] The pooled regression (n=95) is for 1995, 1996, and 1997. The intercepts for the fixed effects model are not reported. Also, the dummy variable D is =1 for a financially riskier utility (i.e., a utility with Moody's bond rating for senior debt of BAA or below), and = 0 otherwise.

*, **, *** Significant at the 0.10, 0.05, and 0.01 level (all one-tailed), respectively.

Table 4 (Continued)

Panel B: Year-by-year Regression Results[a]

Alternative Model: $MVE = \beta_0 + \beta_1 BVA + \beta_2 BVL + \beta_3 U\_ + \beta_4 U\_*D + e$ (2)

YEAR	Intercept	BVA	BVL	U_CC	U_CC*D	U_BO	U_BO*D	U_BASE	U_BASE*D	U_PESS	U_PESS*D	U_OPTI	U_OPTI*D	F-value	Adj R^2
1995	10.69 (1.78)*	0.71 (1.61)**	-0.64 (-1.11)	0.67 (0.78)	-1.49 (-2.02)**									3.77**	0.26
1996	11.57 (2.21)**	0.67 (1.91)**	-0.64 (-1.41)*	0.51 (0.65)	-1.59 (-2.58)***									4.42***	0.30
1997	17.52 (2.32)**	0.96 (2.05)**	-0.99 (-1.69)*	-0.09 (-0.07)	-0.50 (-0.51)									2.20*	0.14
1995	11.49 (1.77)*	1.02 (2.34)***	-1.14 (-1.95)**			0.56 (0.25)	-1.45 (0.55)							2.43*	0.15
1996	13.57 (2.28)*	0.82 (2.19)**	-0.92 (-1.86)**			0.41 (0.21)	-1.30 (-0.54)							1.84	0.09
1997	16.95 (2.22)**	1.04 (2.38)**	-1.12 (-2.04)**			-1.58 (-0.72)	1.83 (0.59)							2.08	0.13
1995	9.53 (1.49)	0.99 (2.35)**	-1.02 (-1.79)**					-0.51 (-0.25)	-0.38 (-0.19)					2.89**	0.19
1996	10.24 (1.82)*	0.80 (2.36)**	-0.80 (-1.77)**					0.17 (0.11)	-1.23 (-0.82)					3.32**	0.23
1997	77.11 (2.26)**	1.00 (2.21)**	-1.02 (-1.78)**					-1.17 (-0.65)	0.83 (0.49)					2.09	0.13
1995	9.45 (1.56)	0.68 (1.54)*	-0.59 (-0.98)							0.37 (1.01)	0.64 (-1.82)**			3.75**	0.26
1996	10.69 (1.96)*	0.65 (1.85)**	-0.61 (-1.32)*							0.23 (0.39)	-0.52 (-2.06)**			3.76**	0.26
1997	17.42 (2.27)**	0.98 (2.16)**	-1.02 (-1.75)**							-0.05 (-0.18)	-0.01 (-0.06)			1.97	.011
1995	9.41 (1.46)	1.05 (2.55)***	-1.12 (-2.00)**									-2.59 (-0.71)	1.31 (0.36)	2.86**	0.19
1996	10.24 (1.79)*	0.82 (2.38)**	-0.84 (-1.82)**									0.09 (0.03)	-1.81 (-0.61)	3.07**	0.21
1997	16.81 (2 .18)**	1.00 (2.20)**	-1.05 (-1.81)**									-1.21 (-0.34)	0.86 (0.25)	1.98*	0.11

[a] In this Table, the dummy variable D is =1 for a financially riskier utility (i.e., a utility with Moody's bond rating for senior debt of BAA or below), and = 0 otherwise. For 1995, 1996, and 1997, n = 32, 32, and 31, respectively.

*, **, *** Significant at the 0.10, 0.05, and 0.01 level (all one-tailed except for intercept), respectively.