Abstract

Studies of the performance effects of public vs. private ownership have found mixed evidence. This paper draws on theory suggesting that public enterprise may have an advantage in producing goods and services whose quality attributes are difficult to specify a priori. Using a comprehensive data set of U.S. electric utilities to estimate cost functions, we find that while privately owned systems achieve lower costs in generation, public systems generally have an advantage in the end-user-oriented distribution function with its more noncontractible quality attributes. Other evidence on quality differences by ownership type and by enterprise size supports this distinction.

Keywords: Public ownership; privatization; electric utilities

JEL: L33, L94

THE COMPARATIVE ADVANTAGE OF PUBLIC OWNERSHIP: EVIDENCE FROM U.S. ELECTRIC UTILITIES

John E. Kwoka, jr. Department of Economics
Northeastern University
j.kwoka@neu.edu
617-373-2252

1. Introduction.

The proposition that private enterprise results in superior cost and price performance has often been represented as a straightforward implication of economic theory and a robust finding of empirical research. Megginson and Netter (2001), for example, state unequivocally that «[r]esearch now supports the proposition that privately owned firms are more efficient and more profitable than otherwise-comparable state-owned firms.» Yet a significant number of empirical studies has always shown equal--and sometimes superior--performance by public enterprises, leading other researchers to rather different conclusions. Boardman and Vining's survey (1989) reports merely «weak support for [the] hypothesis" that "public enterprises...perform less efficiently." Focusing on the ma ny studies of electric utilities, Peters (1993) goes farther, concluding that "the evidence indicates quite strongly that there is either no statistically significant difference..., or that non-profit [i.e., publicly owned] utilities in fact outperform for-profit utilities."

Such divergent readings of the literature are striking and, indeed, beg for explanation. Part of that explanation is simply that the above reviewers survey somewhat different bodies of literature-a fact that should, at a minimum, temper their conclusions. But other researchers have sought the substantive causes of these differences. One important line of inquiry has focused on the magnitude of subsidies to public enterprises, while a second has examined the role of intervening factors such as regulation or competition. But even careful control for these factors has not eliminated divergent findings.[1] This has ultimately left the empirical issue unresolved, and that in turn has prompted renewed theoretical attention to the public-private question.

In contrast to the conventional analysis, recent theory has identified possible advantages of public enterprise under specific circumstances. One line of theory poses public enterprise as a response to the problem of informational asymmetry that besets traditional regulation of a privately owned natural monopoly. Shapiro and Willig (1993), for example, argue that compared to regulators, public «owners» may be better able to secure the information necessary to monitor enterprise behavior for consistency with social objectives. To that extent, while public enterprise may have some deficiencies, it is not necessarily inferior to the (imperfect) alternative of regulation.

Another theoretical approach, based on contract theory, contends that public enterprise may be superior when output has important non-specifiable attributes. Contracts with private providers must set out the price and quality of the service to be rendered, but if quality is more difficult to specify in all relevant dimensions, such quality will be undersupplied (see, e.g., Hart et al (1997)). Public enterprises, by contrast, may have weaker overall incentives and hence higher costs, but those incentives do not favor price over quality, or specifiable quality dimensions over others.

With these last observations as its point of departure, this paper tests the relative advantages of public vs. private enterprises in producing outputs with more specifiable and less specifiable quality. The empirical tests are conducted on the U.S. electric power industry, a choice motivated by three considerations. First, in the time period of the data (1989) this industry had structural characteristics that made it nearly ideal for such a study. These include the fact that both public and private enterprises were--and still are--common and longstanding institutions, avoiding concerns over small samples or transition effects. In addition, both ownership types performed similar tasks--electricity generation, transmission, and distribution-although with somewhat different frequency.[2] And finally, all segments of this industry were at that time regulated and none competitive, so that neither of those potentially confounding factors was at work.

Second, segments of this industry differ in terms of their contractible quality and informational properties. In particular, generation is a large-scale production activity with output sold in broad, impersonal markets. Reliability and other quality concerns are addressed by the existence of large and informed buyers, by contracts that explicitly provide for service interruptibility, and by contractually specified penalties for other supply disruptions. Local distribution of electric power is fundamentally different: Customers are numerous and relatively small. Market- and even customer-specific information is important. Service and reliability criteria are more difficult to specify and enforce. Local control and commitment to quality is arguably more important. Without wishing to exaggerate the distinctions, if it is the case that public enterprise better ensures non-contractible quality, one might expect that it would be in distribution that such enterprises would have advantages, whereas generation is likely to be more efficiently provided by private companies.

The third reason for examining this industry is that the U.S. electric power sector has long been a major focus of performance comparisons of public vs. private ownership. As noted above, these studies do not come to a consistent conclusion, and the reasons for this have been much in dispute. By re-examining electric power using a new framework, the present exercise seeks to resolve some of the ambiguity that characterizes these past results. In addition, while we cannot claim generality to our explanation, the results suggest considerations that may be helpful, and should be examined, in other analyses of public vs. private ownership.

The approach employed in this paper is to adapt a standard model of cost in the electric power industry to allow for the possibly different effects of ownership on generation vs. distribution. After controlling for numerous other factors including possible subsidies, this study finds that publicly owned utilities generally perform better in electric power distribution, whereas private ownership has cost advantages in generation. Further examination finds that the advantage of public ownership is size-dependent, vanishing altogether in the case of the largest of publicly owned utilities. We discuss the likely reasons for this phenomenon. Overall these results underscore the importance of product, market, and provider characteristics to the relative merits of public vs. private enterprise, and challenge the view that either private or public ownership is universally superior.

The next section of this paper more fully describes the industry and the data employed in this study, and offers some preliminary observations. Section 3 outlines the model to be estimated and Section 4 reports the detailed results of that estimation. Section 5 illustrates how studies that fail to draw the relevant distinctions may overlook important effects. A final section summarizes.

2. The Electric Power Industry

The U.S. electric power industry has long consisted of a large number of very diverse entities. From the 1970s until the restructuring of the mid-1990s, there were about 250 privately owned utilities, two thousand public enterprises, one thousand rural cooperatives, and a dozen federal power projects. Privately owned utilities are perhaps the best known, since they have tended to be individually larger, vertically integrated, and collectively responsible for more than three-quarters of all electric power produced and sold. Their vertical integration entailed simultaneous operation in all stages-generation, transmission, and distribution of power. As franchised monopolies, privately owned utilities (sometimes called «investor-owned utilities,» or IOUs) have traditionally been subject to cost of service regulation by state utility commissions.

Publicly owned systems emerged as alternatives to private enterprise in the early 1900s, especially in smaller cities and towns where private capital was slower to make its appearance. The number of municipally owned utilities («munis») grew to a maximum of about 3000 in the early 1920s, but shrank as it became apparent that such fragmentation was sacrificing significant scale economies. Over time munis came increasingly to rely upon IOUs and federal power projects for actual electricity generation, focusing instead on local distribution. Despite their numbers, munis account for only about 15 percent of total power sold in the U.S., and significantly less of power generation. While most such systems are small, a number of large cities-including Los Angeles, Seattle, Detroit, San Antonio, and Cleveland--are served by fully integrated publicly owned electric utilities.

Although they are not the focus of this research, the other two categories of electric utilities deserve mention. Rural electrical coops arose during the 1930s to ensure electrification of sparsely populated rural areas. While numerous, almost all coops are quite small and perform only distribution functions. Federal power agencies were also created in the 1930s in order to operate the massive hydro power projects being built on the Tennessee River and elsewhere. There are now a dozen such entities-the best known being TVA--largely devoted to power generation and its sale to IOUs, munis, and coops for retail distribution. Rural coops and federal power projects are fundamentally different in purpose, structure, and governance, and hence are not part of this study.

This study focuses on the performance of IOUs and munis. The data set includes all private utilities and the largest publicly owned systems in 1989 for which comparable data could be found-147 of the former plus 396 of the latter.[3] This is the most comprehensive data set that has been employed for such purposes. As shown in Table 1, the included utilities account for a very large fraction of total electric power sales in the U.S. in that year. This table also reveals the very different degree to which each type of utility engages in electricity generation vs. distribution.[4] Only 41 percent of publicly owned utilities generate any power at all, whereas 95 percent of IOUs are engaged in at least some generation. Moreover, IOUs generate fully 74 percent of the amount of power that they sell, compared to only 17 percent for public systems.

This relative specialization is not likely due to chance. A chi-square test on the frequency of public vs. private ownership in generation vs. distribution results in a test statistic of 123.8, overwhelmingly inconsistent with the proposition that the distribution is random. Furthermore, a t-test on the difference in the percent of internally generated power between IOUs and munis yields a test statistic of 18.0, also highly significant. On their face, these facts support our hypotheses: For production-oriented activities involving more standardized products transacted in impersonal markets and whose quality is easier to monitor and enforce-that is, wholesale generation--the incentive structure of private enterprise dominates. By contrast, distribution has more substantial non-specifiable quality dimensions and, in addition, information about end-use markets is more important. Here public enterprise is likely to play a larger role, and indeed it does. Association is not causation, of course, and so we shall test these hypotheses more systematically in the next section.

3. Model and Data for Utility Costs

In this section we set out the model to be estimated, describe the data, and offer some preliminary observations about performance differences between publicly owned and private electric utilities.

3.1 MODEL OF UTILITY COSTS

The usual cost functions in the literature on the electric power industry have two limitations for present purposes. First, most have been single-product functions, whereas our hypotheses require use of a multiproduct framework in order to capture both generation and distribution outputs.[5] Second, those that do test for cost differences due to ownership employ a simple shift or slope term on some measure of aggregate output. By contrast, our purposes require a specification that allows for different possible effects of ownership on each output. As we shall see, specification choice makes a substantial difference.

A further issue that needs to be addressed concerns the choice of functional form. Both the translog and the quadratic forms have been commonly used in estimation of electric utility cost functions. For present purposes, however, the quadratic has the clear advantage that it handles zero values of variables-such as certain outputs and fixed effects terms in the specification below--more easily than does the translog.[6]

We therefore proceed with a cost function that is quadratic in outputs *DIST* and *GEN,* denoting distribution and generation outputs, respectively. Omitting other factors for the present, this may be written:

$$C(DIST, GEN) = a_0 + a_{11}\, DIST + a_{12}\, DISTSQ + a_{21}\, GEN + a_{22}\, GENSQ + a_3\, DIST \bullet GEN \qquad (1)$$

Total cost *C(DIST,GEN)* is the sum of costs associated with power generation, distribution, purchase, and overhead, together with depreciation and imputed capital charges, as discussed above. The variables *DIST, DISTSQ, GEN, GENSQ,* are linear and quadratic output terms. The interaction term *DIST●GEN* captures possible economies of vertical integration since if joint production of *DIST* and *GEN* confers a cost advantage relative to their separate production, a_3 should emerge with a negative sign. If joint production is equally costly or more costly, that coefficient will be zero or positive, respectively.[7]

Two additional variables are required by the output specification in this equation. The first is *FCGEN*, a fixed effects term for utilities for which *GEN* > 0. This term allows for any fixed costs that are specific to generation but do not arise in distribution. A second variable is the amount of power purchased by the utility. Most utilities both generate and purchase some power, and *PURCH* is included to control for the magnitude of power purchase costs in total cost.[8]

3.2 DATA ISSUES

Total costs are defined as the sum of operations and maintenance expenses (O & M), depreciation, and capital costs. O & M in turn consists of the costs of power supply (generation and/or purchase), transmission and distribution, and overhead. The latter category includes customer accounts, customer service, sales, and administrative and general expenses. The basic data source for these variables are DOE (1991a, 1991b).

Capital costs are calculated as the price of capital multiplied by net electric plant, where the price of capital is the weighted average cost of common stock, preferred stock, long-term debt, and certain capital-like items specific to public systems.

The return to common stock is measured as fourth-quarter dividends paid, annualized and divided by year-end stock price.[9] Since publicly owned firms do not issue ownership shares, their cost of capital includes neither common nor preferred stock. They often do have certain capital and related transfers from their municipalities. These items-termed "investment by municipality" and "constructive surplus/deficit" in the regulatory accounts--are here treated as interest-free loans in order to fully allow for their arguable status as subsidies to munis.

A number of other variables are included to complete this model. Input costs are represented by the prices of fuel (*PRFUEL*), labor (*WAGE*), and capital (*PRCAP*). Fuel price is calculated as the weighted average expense, per mwh, of fuel used in steam generation and in nuclear generation for those utilities that engage in each (DOE, 1991a, 1991b). For labor costs, total payroll data are available, but the absence of employment numbers for many publicly owned utilities precludes calculation of utility-specific wage costs. Instead, we utilize the all-manufacturing wage in the utility's state (Bureau of the Census, 1991). The definition of the price of capital has already been given. Each of these factor costs is interacted with the output to which it relates-*PRFUEL* with generation, *WAGE* and *PRCAP* with both generation and distribution.

Other control variables that may affect costs are suggested by theory and previous literature. These include the number of customers, the type of generating capacity, and possible membership in a holding company. The total number of residential, commercial, and industrial customers served by each utility (*CUSTOM*) affects both administrative and production costs, the latter by virtue of the need for voltage changes to serve small customers. The percentages of a generating utility's capacity that are nuclear and hydro are measured by variables with those names. Relative to conventional steam generation, nuclear is expected to have higher costs, while hydro should be cheaper. Finally, previous literature suggests that utilities that are subsidiaries of holding companies may realize cost savings from centralized accounting, dispatch, investment, and other tasks. Those subsidiaries are distinguished from fully independent utilities by the fixed effects term *HCSUB*. All of these additional data are from DOE (1991a, 1991b). All variables, together with their units and scale, are listed in Table 2.

3.3 PRELIMINARY OBSERVATIONS

An initial examination of the data provides some insight into relative performance by ownership type. Perhaps most notably, the mean average cost for all publicly owned systems is 5.50 cents per kwh, compared to 5.60 cents per kwh for IOUs-a difference that is not statistically different (t = 0.63). Although average cost may not differ between IOUs and munis, its composition does. Average O & M costs are significantly higher for munis--4.86 cents per kwh compared to 4.00 cents for IOUs.

These are offset by significantly lower capital charges for munis--0.348 cents per kwh compared to 1.002 for IOUs. Both differences are a reflection of munis’ distinctive power sources-more purchased power and less internally generated power, and hence lower capital charges, than for IOUs.

These data address the frequent contention that the cost advantages of publicly owned utilities are due to subsidies. Three such subsidies are commonly alleged-lower cost of capital due to tax-exempt municipal bond financing, preferential access to low-cost hydro power, and the avoidance of income taxation. While publicly owned firms' cost of capital is indeed lower, in the present data set that lower cost is measured by *PRCAP* and its effect captured in the model. Similarly, public systems' differential access to low-cost hydro power is reflected in their higher recorded purchases of such power. Tax differences are simply excluded from this production cost model. Therefore, any cost differential that emerges cannot be attributed to these factors. We now turn to a cet. par. comparison of cost differences

4. Results of Estimation

The total cost model shown in equation (1), augmented in various ways, is estimated on the 543 utilities in the data base and the key results are reported in Table 3. We shall begin with a benchmark model of utility costs, and then introduce the distinction between public and private utilities so as to reflect the contracting/quality distinctions between distribution and generation that are outlined above.

4.1 BENCHMARK COST MODEL

The benchmark cost model includes seven variables representing output-*DIST* and *GEN*, their squares and their interaction, plus *FCGEN* and *PURCH*. We expect all output terms to be positively related to total costs with the exception of the interaction term *DIST*$*GEN,* whose sign is theoretically ambiguous. There are, in addition, five factor cost interaction terms plus four other control variables. We expect positive signs on the factor cost terms as well as on the variables measuring dependence upon nuclear power and the number of customers. Lower costs can be expected from greater use of hydro power and from membership in a holding company, so the signs of those variables should be negative.

The results of estimation of this benchmark model are shown in column (a) of Table 3. All but two of the sixteen predicted signs on coefficients are confirmed, and neither of the exceptions-those on *GEN* and on *WAGE*●*DIST*-is statistically significant.

The positive coefficients on both quadratic output terms-*DISTSQ* and *GENSQ*--impart convexity to the cost function with respect to each output, so that the function exhibits product-specific diseconomies of scale. The negative coefficient on *DIST*●*GEN* implies that joint production of distribution and generation is less costly than standalone production of *DIST* and *GEN*. This effect--cost complementarity--represents one condition for (positive) economies of vertical integration. The variable measuring purchased power carries the expected positive sign and is statistically significant. Although *FCGEN* is positive, as expected, it is not statistically significant.

Other variables for the most part behave predictably. Fuel price, interacted with generation output, is strongly related to cost, as one would expect. Other factor cost interaction terms are individually less significant, but since these are not the variables of primary interest we are less concerned, so long as all appropriate control variables are included. Moreover, the insignificance of these terms is due to the high correlations-in excess of .97--between *WAGE*●*DIST* and *WAGE*●*GEN* and, separately, between *PRCAP*●*DIST* and *PRCAP*●*GEN*. Both of these pairs of terms are jointly highly significant, leaving no doubt about the role of these factor costs in production.[10] We continue to include them separately as a matter of consistency with the present multiproduct framework.

Additionally, dependence upon nuclear power is found to increase a utility's cost while greater reliance upon hydro power lowers it. Total customer count is strongly related to costs, confirming the previously noted reasons that more numerous customers are more costly to serve. And subsidiaries of holding companies (indicated by *HCSUB*) do indeed have significantly lower total costs than unaffiliated utilities. As others have found, this model specification performs well in capturing the determinants of utilities' costs: More than 96 percent of the variation in total costs is explained, comparable to or slightly higher than other cross-sectional studies in the literature.

4.2 THE ROLE OF PUBLIC OWNERSHIP

Our hypotheses are that publicly owned utilities perform better in distribution, with its end-user orientation and its noncontractible quality attributes, while IOUs can be expected to have advantages in the more impersonal commodity-like wholesale market for generation. The benchmark cost model does not test these hypotheses since it does not permit different effects of public ownership in generation vs. distribution.

To do so, we first define a fixed effects term *PUBLIC* that takes on a value of one for publicly owned utilities and zero for IOUs. Then we augment the previous model with two terms, one each for the interactions of *PUBLIC* with *GEN* and with *DIST.* The resulting equation is therefore:

$$C(DIST, GEN) = a_0 + a_{11}\, DIST + a_{12}\, DISTSQ + a_{21}\, GEN + a_{22}\, GENSQ + a_3\, DIST \bullet GEN + \beta_1\, PUB \bullet DIST + \beta_2\, PUB \bullet GEN + e \tag{2}$$

By not constraining the coefficients on *PUB●DIST* and on *PUB●GEN* to be identical, this specification permits public ownership to have different effects in producing the two outputs. Our key hypotheses imply that publicly owned utilities are likely to have lower costs in distribution ($\beta_1 < 0$) but higher costs in generation ($\beta_2 > 0$).

The results of estimating this model are reported in column (b) of Table 3. All of the output and control variables perform similarly to the results in column (a)--indeed, with several now more highly significant. We shall not comment further on these variables here or in later results. More to the present point, the coefficient on *PUB●DIST* is negative and statistically significant while that on *PUB●GEN* is positive and significant, precisely as predicted. Public ownership indeed does result in lower costs of distribution than for a privately owned utility, holding operating characteristics, factor prices, and any subsidies constant. This strongly supports the hypothesis that public ownership affords an advantage in user-oriented tasks and services with attributes that may be difficult to specify contractually. By contrast, in power generation-a production-oriented activity with a primary emphasis on low costs--the positive coefficient on *PUB●GEN* implies that it is IOUs that achieve lower costs.

These estimated effects underscore the relevance of the generation-distribution distinction in analyzing the impact of public ownership of electric utilities. And more generally, they suggest an important new consideration that may influence the measured effects of public ownership. We probe this results further, partly to ensure their robustness but also to identify any important variations. In column (c) we estimate the same model as in column (b) modified by reintroducing the fixed effects variable *PUBLIC* itself. This now allows for any differences specifically in the fixed costs incurred under public ownership.

The estimated coefficient on *PUBLIC* in column (c) reveals that public owned utilities operate with lower fixed costs than do private systems. That difference-large and statistically significant-captures a further difference between the cost structures that characterize public vs. private ownership in the electric power industry. It should be noted that the inclusion of *PUBLIC* somewhat reduces the magnitude of the effects measured by *PUB●DIST* and *PUB●GEN*. The higher cost of generation in the case of publicly owned utilities nevertheless remains highly significant, while their lower distribution costs are now significant at 6 percent in a two-tail test, or at 3 percent in a (arguably more appropriate) one-tail test. Collinearity is starting to take its toll on individual coefficients as the number of output-related terms proliferate.

With this last caveat in mind, we can nonetheless take this estimation one further, and revealing, step. Specifications (b) and (c) are sufficiently flexible to permit public vs. private ownership to have different effects in generation and distribution, but those differences are linear in nature-that is, on *DIST* and *GEN* only--whereas the underlying production function is quadratic. We therefore add to the model in column

(c) two additional terms interacting *PUBLIC* with the squares of *DIST* and *GEN*, thereby permitting the function to take on a different shape depending upon ownership of the utility. While we continue to anticipate lower distribution costs and higher generation costs from public systems, the expected signs of the quadratic terms in particular are unclear.

The results of this estimation are reported in column (d). While the statistical significance of individual coefficients is now generally eroded by collinearity, the coefficient estimates for *PUB●DIST* and *PUB●GEN* are negative and positive, as before, with that on *PUB●DIST* remaining significant. *PUB●DISTSQ* enters with a positive sign and is significant at 17 percent, while the coefficient on *PUB●GENSQ* is negative but altogether insignificant (t = .08). It seems appropriate to conclude that the effect of public ownership on generation has been fully measured by the linear term, which, to repeat, indicates higher cost to public systems.

As for distribution, the negative linear term is a persistent result, but the emergence of a positive coefficient on the quadratic term, albeit of borderline significance, prompts a closer look. After all, the latter term might outweigh the cost reduction captured in the linear term and reverse our previous inference suggesting an advantage to public ownership in distribution. Taking the results at face value, the range of output for which public ownership results in a net distribution cost reduction is given by the following expression derived from the estimated coefficients in column (d):

$$- 36.0\ DIST + 2.38\ (10^{-6})\ DISTSQ + 32.3\ (10^{6}) < 0 \qquad (3)$$

This inequality is satisfied for all *DIST* < 16.0 million mwh, implying that only distribution utilities of less than this size actually achieve lower cost. Three observations are relevant to this result.

First, of the 543 utilities in the data set, 56 have distribution output in excess of sixteen million mwh. Of those, however, only two are publicly owned---the Los Angeles Department of Water and Power (21.9 million mwh) and the Salt River Project in Arizona (17.2 million mwh). Thus, scarcely any publicly owned utilities fall in the range where they lack a demonstrated comparative advantage. Put differently, of the 396 publicly owned systems in the data base, 394 lie below this cutoff value. The overwhelming majority of pub lic systems specialize in the particular function and in the output range for which they have a cost advantage over their privately owned counterparts.

Second, the fact that the advantage of public ownership diminishes with size and is subject to reversal in the case of very large distribution utilities is itself noteworthy. Our core hypothesis has been that public ownership is superior in end-user-oriented tasks where quality and reliability are otherwise more difficult to sustain. Compared to power generation, this is a better description of the distribution function, but it can also be said that it is a better characterization of *small* distribution systems rather than *large* ones. Large distribution systems may be sufficiently divorced from end users that they operate similarly whether publicly or privately owned. Put differently, large organizations tend to have low-power incentives because they are likely to have multiple objectives with varying degrees of observability or measurability (Dixit (1997)). Thus, the finding that the largest publicly owned distribution systems have no advantage over their private counterparts can be seen as a reflection of the same theoretical considerations as previously advanced.[11]

Finally, it should be noted that at this (and all) output levels, the results in column (d) imply that generation costs are higher for public systems than for their private counterparts. Since distribution costs are lower for most publicly owned utilities, the net effect of higher generation costs and lower distribution costs is an interesting empirical question. Given the interdependency between the two, the answer depends upon the exact output configuration for which the calculation is performed. Utilizing the results in column (d), and evaluating at the means of all variables, we find that public ownership results in a net generation-plus-distribution costs savings of 2.5 percent. It should be stressed that this is indeed the mean effect, with greater cost savings at smaller outputs, and at larger outputs smaller cost savings and eventual reversal of the net cost effects.

4.3 QUALITY AND PUBLIC OWNERSHIP

These results show that all but the largest publicly owned utilities deliver distribution services at lower costs than do their privately owned counterparts. Since the theory also emphasizes the relationship between public ownership and quality performance, these findings imply that publicly owned utilities achieve sufficiently lower costs to offset the added costs of higher quality--presuming, of course, that their quality is indeed higher. If the latter is not the case, then equal or lower costs under public ownership might simply reflect poorer quality, rather than greater efficiency in providing the same or superior quality service.[12]

Evidence concerning service quality is imperfect, but there are some relevant data on the most common measure of quality, namely, reliability of distribution service.

System Average Interruptible Duration Index (SAIDI) is defined as the average annua l number of minutes a retail customer is without service. SAIDI values for samples of both publicly owned and investor owned utilities in various years have been compiled and reported by Resource Management International and by industry sources. The mean values by ownership type are shown in columns (a) and (b) of Table 4. As is evident, service interruption values for IOUs are substantially greater than for munis, generally by a factor of about two, in every year. Despite some limitations, these data strongly suggest that munis provide more reliable service than their IOU counterparts, and do so both consistently and by a considerable margin.[13]

Supportive evidence on another implication of this study may be found in these data. As shown in Columns (c), (d), and (e) of Table 4, SAIDI values are also collected and reported according to the size category of the utility. Large and medium size utilities experience similar mean values, but interruption durations are considerably lower-that is, reliability is higher--for small utilities. This again holds for all years and by a wide margin, and is consistent with (though not proof of) our finding that the advantage enjoyed by munis is reversed when they achieve large size. There is, in short, good if not perfect evidence of quality differentials by ownership type and utility size much as implied by the model and empirical evidence developed earlier.[14]

5. A Methodological Note

This analysis paints a considerably more complex picture of the effects of public ownership than previously recognized. Armed with these insights, we can return to the issue with which we began-the apparent inconsistency of past studies of public ownership. As noted, studies in the literature have reported positive, negative, and sometimes no effects. It can now be shown that the failure to draw the relevant distinctions has almost surely contributed to that inconsistency.

To see this, we consider a standard approach to testing for possible cost differences between public and private systems-namely, to take a model like that in equation (1) and then simply add the fixed effects term *PUBLIC*.[15] That produces the following estimating equation:

$$C(DIST, GEN) = a_0 + a_{11}\, DIST + a_{12}\, DISTSQ + a_{21}\, GEN + a_{22}\, GENSQ + a_3\, DIST \bullet GEN + ß_0\, PUBLIC + e \qquad (4)$$

Table 5 reports the results of estimating this equation on the present data set. The results are not unlike many in the literature: The coefficient on *PUBLIC* is negative, but it has a t-statistic of only .72-not significantly different from zero. As a result, no confident conclusion can be drawn from this specification that publicly owned utilities achieve costs different (either higher or lower) from IOUs.

Thus, studies that have searched for cost effects of public ownership with this model specification would conclude-and often have concluded--that none exists. As we have just seen, however, a specification that flexibly allows public ownership to affect distribution and generation costs differently finds strong evidence of such effects on this very data set. An inflexible modeling approach, by contrast, combines two offsetting effects in the different industry sectors, and may thereby lead to the erroneous conclusion that there is no ownership effect at all.

V. Conclusions

This research finds that public and private enterprises each have a comparative advantage in different facets of the U.S. electric power industry. Privately owned utilities are superior in impersonal markets with more specifiable products or services-namely, power generation-whereas public ownership has advantages in the customer-oriented tasks of retail distribution. Interestingly, the latter effect is itself a function of size, underscoring the need for close proximity to customers in order to achieve those benefits.

These results provide support for newer theories of public ownership, which identify possible advantages over private ownership in the provision of certain services. The results provide a cost-based explanation for the actual patterns of ownership in the U.S. electric power sector. And they provide an explanation for the often inconsistent or inconclusive results of past research into the performance effects of public ownership in electric power.

These findings suggest that the longstanding debate over public vs. private ownership may require some rethinking. From a research perspective, rather than searching for uniform superiority of either private or public enterprise--an objective that has eluded past research in any event--this study suggests the need to identify product, market and proviser characteristics best suited to each ownership type. From a policy perspective it cautions that the quest for superior performance is not simply a matter of prescribing privatization. There are identifiable circumstances in which public enterprise is an appropriate, if not perfect, policy prescription. Both research and policy require a more sophisticated view of the effect of ownership on enterprise performance.

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FOOTNOTES

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1. See, for example, Hayashi et.al. (1987), Newbery (1997), Newbery and Pollitt (1997), Kole and Mulherin (1997), and Wallsten (2002).
2. This ensures that a study distinguishing generation and distribution is not simply a study of a potentially competitive sector vs. a nature monopoly. All IOUs in the data base also distributed power, and a substantial number of munis were involved in generation. See Table 1 and related discussion in the text.
3. The principle data sources are two Department of Energy publications on electric utilities (DOE, 1991a, 1991b). Other sources are noted in conjunction with specific variables below.
4. As is common in this literature, transmission is included with distribution. This is partly due to their rough similarity, but equally to the need to limit the dimensionality of the empirical analysis, as will be discussed.
5. For a survey of utility studies, see (e.g.) Peters. While there are a few multiproduct studies of electric power, none addresses the present question. Hayashi et al, for example, specify a cost function with residential, commercial, and industrial power as their three products. Work by Kaserman and Mayo distinguish generation vs. distribution, but they are investigating vertical economies and their data in any event do not include publicly owned utilities.
6. While in principle the Box-Cox transformation can allow for zero-valued variables in the translog cost function, Roller (1986) reports that the translog nonetheless results in less reliable estimates than does the quadratic in important ranges of the data. The primary limitation of the quadratic is that it is not linearly homogenous in factor prices. It has nonetheless often been used in the literature. In addition to Roller, see Kaserman and Mayo, Kwoka (1996).
7. For further discussion of vertical economies, see Kaserman and Mayo, Gilsdorf (1994), and Kwoka.
8. While it would be preferable to include the price of purchased power, that variable is not reliably reported for all utilities. Data on actual gross purchases are much more complete and consistent (DOE, 1991a, 1991b). The behavior of this variable, especially the estimated coefficient reported below, would suggest that it is properly controlling for purchased power expenses.
9. This measure of capital cost is similar to those employed in Hayashi et al and Kaserman and Mayo (1989), among others. It captures the costs that a utility must recover in its revenue operations. See discussion in Grout (1995).
10. A test of the joint significance of *WAGE•DIST* and *WAGE•GEN* produces an F(2, 526) = 7.76, significant at better than .001. A test on *PRCAP•DIST* and *PRCAP•GEN* has an F(2, 526) = 12.46), also significant at better than .001. Clearly these collinear factor cost term are quite significant.
11. A similar size-related phenomenon is reported in Koh et al (1996) with respect to steam

generation costs by public vs. private utilities. While they interpret this as indicative of voters' increasing difficulty in monitoring larger public systems, it seems doubtful that monitoring costs are related to public systems' generation output only (and just steam generation at that). For an interesting examination of the LA Department of Water and Power that finds its cost structure to be higher in comparison utilities, see Barrington-Wellesley Group (1994).

12. Indeed, public ownership of enterprises-especially, traditional state-owned companies like steel, autos, and airlines-has often been associated with lower quality output. A number of authors explain this in terms of weakness in oversight of public enterprise, or indifference toward quality, or simple corruption (see, e.g., Shleifer (1998)).

13. The limitations include the absence of controls for other possible factors and of course the fact that SAIDI data are for fewer utilities than (and not matched to) those in the present data set.

14. Somewhat more indirect evidence concerning IOU and muni cost structures may be found in price data for these utilities. The mean price charged by IOUs in this data base is 6.25 cents per kwh, compared to 5.81 cents to munis, again supporting the proposition that muni performance is no worse than-in some respects superior to-that of IOUs.

15. See, for example, the widely cited study by Atkinson and Halvorsen (1986).

TABLE 1
ELECTRIC UTILITIES IN DATA BASE (1989)

	OVERALL	PRIVATE	PUBLIC
Number of utilities in data base	543	147	396
Percent of total sales accounted for	87.2	97.8	83.0
Number that generate some power	302	139	163
Percent that generate some power	56.6	94.6	41.2
Percent of own sales that is generated	32.3	74.0	16.8

TABLE 2
IDENTIFICATION OF VARIABLES

TOTAL COST	Sum of operation and maintenance, depreciation, and capital costs (●10^8)
DIST	Distribution output (mwh x 10^6)
GEN	Generation output (mwh x 10^6)
FCGEN	Fixed cost of generation (= 1 if GEN > 0)
PURCH	Purchased power (mwh x 10^6)
PUBLIC	Publicly owned utility (= 1)
NUCLEAR	Percent capacity that is nuclear
HYDRO	Percent capacity that is hydro
WAGE	State average manufacturing wage ($/hr.)
PCAP	Weighted average price of capital (%)
PFUEL	Weighted average price of fuel ($/mwh)
CUSTOM	Total number of customers
HCSUB	Subsidiary of holding company (= 1)

TABLE 3 REGRESSION ANALYSIS OF EFFECT OF PUBLIC OWNERSHIP ON TOTAL COST

Independent Variable	a	b	c	d
DIST	22.0	49.8	44.8	44.5
	(.83)	(1.91)	(1.72)	(1.74)
DISTSQ(10^{-6})	1.67	1.43	1.56	1.55
	(4.52)	(3.99)	(4.33)	(4.36)
GEN	-38.6	-82.0	-79.8	-79.8
	(1.37)	(2.93)	(2.86)	(2.91)
GENSQ(10^{-6})	1.85	1.86	1.93	1.91
	(4.90)	(5.12)	(5.32)	(5.33)
DIST · GEN(10^{-6})	-3.43	-3.16	-3.33	-3.32
	(4.66)	(4.45)	(4.69)	(4.72)
FCGEN(10^{6})	10.1	0.67	-8.23	1.88
	(.77)	(.05)	(.63)	(.14)
PURCH	15.5	14.4	12.0	11.8
	(2.15)	(2.04)	(1.68)	(1.69)
PUB · DIST		-23.1	-15.8	-36.0
		(2.90)	(1.87)	(2.07)
PUB · GEN		46.4	42.6	27.9
		(5.16)	(4.69)	(1.49)
PUBLIC(10^{-6})			-52.9	-32.3
			(2.55)	(1.52)
PUB · DISTSQ(10^{-6})				2.38
				(1.38)
PUB · GENSQ(10^{-6})				-15.2
				(.08)
NUCLEAR(10^{6})	395.	403.	395.	413.
	(6.80)	(7.23)	(7.11)	(7.48)
HYDRO(10^{6})	-41.5	-52.1	-56.6	-42.6
	(1.48)	(1.92)	(2.09)	(1.59)
WAGE · DIST	-.434	-3.19	-2.71	-2.21
	(.10)	(.77)	(.66)	(.55)
WAGE · GEN	1.83	3.38	3.14	2.86
	(.81)	(1.55)	(1.45)	(1.34)
PCAP · DIST	199.	164.	154.	127.
	(1.20)	(1.04)	(.97)	(.81)
PCAP · GEN	109.	230.	245.	290.
	(.54)	(1.18)	(1.27)	(1.51)
PFUEL · GEN	1.05	1.32	1.30	1.27
	(6.62)	(8.38)	(8.33)	(8.27)
CUSTOM	231.	262.	270.	269.
	(7.23)	(8.36)	(8.61)	(8.73)
HCSUB(10^{6})	-128.	-132.	-143.	-143.
	(4.92)	(5.17)	(5.55)	(5.63)
CONSTANT(10^{6})	2.38	7.43	58.3	44.5
	(.27)	(.85)	(2.68)	(2.06)
R2	0.965	0.968	0.968	0.969
F	902	877	840	877

TABLE 4

MEAN INDEX VALUES FOR SAIDI

	Ownership		Size[5]		
	(a)	(b)	(c)	(d)	(e)
Year	IOUs	Munis	Large	Medium	Small
1991[1]	228	103			
1992[1]	104	44			
1993[1]	139	77			
1994[1]	182	86			
1997[2]	165	74	162		79
1999[2]	210	107[3]	184	206	95
2000[2]	86[4]	23[3,4]	57	68	17
2001[2]	174	121[3]	166	179	113

Notes:

(1) Based on “over 100 public power systems” and “over 30 investor owned utilities”
(2) Categories generally have 25-40 utilities each
(3) Includes coops. Where separated, coops’ SAIDI is larger than for munis
(4) Medians; means not given
(5) Break points generally at 750 – 800,000 customers and 100 – 125,000 customers

Sources: 1991-1994, The Relative System Reliability of Publicly Owned and Privately Owned Electric Utilities, Resource Management International (1996)
1997-2001, for IOUs, Annual Electric Distribution Reliability Best Practices Survey, Hagler Bailey/PA Consulting Group
1997-2001, for Munis, American Public Power Assn.

TABLE 5

CONVENTIONAL ANALYSIS OF PUBLIC OWNERSHIP AND TOTAL COST

DIST	21.5
	(.81)
DISTSQ(10^{-6})	1.69
	(4.58)
GEN	-38.3
	(1.36)
GENSQ(10^{-6})	1.86
	(4.92)
DIST · GEN(10^{-6})	-3.46
	(4.69)
FCGEN(10^{6})	7.60
	(.56)
PURCH	15.4
	(2.13)
PUBLIC(10^{-6})	-13.6
	(.72)
NUCLEAR(10^{6})	393.
	(6.74)
HYDRO(10^{6})	-41.3
	(1.47)
WAGE · DIST	-.390
	(.09)
WAGE · GEN	1.80
	(.80)
PCAP · DIST	194.
	(1.17)
PCAP · GEN	112.
	(.56)
PFUEL · GEN	1.04
	(6.53)
CUSTOM	231.
	(7.22)
HCSUB(10^{6})	-133.
	(4.95)
CONSTANT(10^{6})	15.9
	(.76)
R^2	.965
F	848