THE ROLE OF COMPETITION IN NATURAL MONOPOLY:
COSTS, PUBLIC OWNERSHIP, AND REGULATION

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I. INTRODUCTION

Although the relationship between competition and price receives more attention, the effect of competition on costs may be at least as important. Indeed, competition-induced cost reductions are one reason that price declines, and by some measures they exceed the reductions in deadweight loss from price competition itself (Scherer and Ross (1990), p. 672). But where production technology is characterized by significant economies of scale, classical competition involving multiple firms would seem to be an unpromising approach: While the cost frontier may be more closely approximated as firms are forced to minimize unit cost for given output, each firm falls short of minimum efficient scale, thus raising its unit cost. For this reason, the preservation of multiple firms of suboptimal scale is scarcely ever endorsed as good policy.

That conclusion may be too facile, however, for two reasons. First, the trade-off between a closer approximation to the cost frontier and the sacrifice of scale economies is an empirical question, and not one that necessarily favors the full-scale monopoly firm with its excess costs. Second, the monopoly that results from realization of all economies is usually accompanied by public ownership or regulation, each of which has its own well-known limitations with respect to cost minimization. Thus, in a world of second (and perhaps third) best choices, the possibility that competition might have a role even in the face of persistent scale economies cannot be ruled out.

There are two forms that competition might take. Perhaps the most obvious is suggested in the discussion above: A second firm (and perhaps others) might be present in the market, fostering price competition between them that imposes cost discipline as well. But there is, in addition, an alternative competitive mechanism that may be beneficial in some markets. Where monopoly is permitted, prevention of the full exercise of its market power is usually through either public ownership or regulation. In both forms of social control, there is an overseer of firm conduct which operates under an informational asymmetry with respect to actual minimum costs, hindering its effort at social control. The existence of other firms in separate but sufficiently similar markets can help in judging costs and prices in the market directly overseen. Note that in contrast to actual competition, such “benchmark competition" permits control over cost behavior without sacrificing economies of scale since no second firm operates in the same market.

This paper addresses this set of interrelated issues from an empirical perspective. We draw on the considerable set of relevant experiences involving electric distribution utilities in the U.S. While the vast majority of jurisdictions in the U.S. are served by monopoly distribution entities, a nontrivial number have two distribution systems within their boundaries. That by itself presents an unusual opportunity to evaluate the effect on costs of introducing competition into a natural monopoly setting, but two other features of these cases significantly extent the analysis.

First, in some instances the utilities are true duopolists, with duplicative facilities and direct competition for customers on an on-going basis. This represents the most obvious and straightforward means of competition in these markets. But in other cases the two utilities' service territories, while in the same jurisdiction, are fixed and exclusive, so that facilities duplication is avoided and direct competition does not occur. In these cases, proximity and similarity of the utilities may allow public overseers and regulators to exercise control over costs and prices via benchmark competition. Focusing on these experiences permits testing for any effect from benchmark competition, and if it exists, measuring its effect and drawing comparisons with the effect of direct competition.

The second important distinction in these experiences is that most of the duopolies consist of two quite different types of enterprises. One utility in each pair is typically privately owned and regulated, while the other is likely to be a publicly owned system. Although the relative costs of public vs. private ownership is itself an interesting (and well researched) question, for the purposes of the present study this fact implies that we need to recognize that source of possible cost differences in order to isolate the incremental effect of competition. Put differently, there is no reason why direct competition need have the same effect on costs of a publicly owned system as on a private system, and hence our analysis must permit the two to differ.

We proceed as follows: We begin by estimating a standard cost function for the distribution sector of the U.S. electric power industry, allowing for the presence of competition of either form.

Consistent with expectations, we find that competition lowers overall costs for the average utility, and does so by reducing operating costs sufficiently to offset the higher fixed costs of operation. The overall average cost reduction from competition is 1.7 percent, which may therefore be interpreted as a measure of the cost inefficiency of the typical regulated monopoly. Next we distinguish direct vs. benchmark competition and find that both reduce costs, with fixed cost differences now important only in the case of direct competition–precisely the case where duplication actually occurs. Remarkably in these results, similar overall effects on costs arise from both types of competition–direct and benchmark.

Finally, distinguishing regulated private utilities and publicly owned systems produces the striking result that competition reduces costs only for the former. Put differently, costs are equally low for a publicly owned monopoly as for a publicly owned utility facing competition. But since the latter achieves cost approximating the true minimum cost, these results imply that public ownership even without competition achieves cost efficiency. By contrast, costs under regulation are significantly higher without competition. Taken together, these results strongly suggest that the imperfections of the regulatory process exceed the imperfections of public ownership. Public ownership seems quite capable by itself of bringing cost pressure to bear on natural monopoly.

This paper is structured as follows. The next section focuses on the relevant theory regarding the effect of competition on costs. The issues with respect to regulation and public ownership are well-known and do not need further explication here.[1] Section III describes the U.S. electricity sector, with its publicly owned and regulated enterprises, and with particular attention to cases of competitive utilities. Section IV reports the results of estimating a cost function that measures the effects of competition on utility costs, drawing distinctions between direct and benchmark competition and between publicly owned and private firms. Section V offers some brief conclusions and further implications of these results for policy.

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[1] The imperfections of regulation as well as public enterprise performance are discussed in most textbooks. See, for example, Viscusi, et al.

II. THE EFFECT OF COMPETITION ON COSTS

This section sets out the simple analytics describing the relationship between competition and costs. We first examine duopoly competition in the context of pervasive economies of scale, and then the case of benchmark competition where comparable firms are used to impose cost discipline on monopoly sellers subject to regulatory oversight or public ownership.

1. Direct Competition and the Cost Trade-Off

Consider a jurisdiction that might be served either (a) by a single publicly owned or regulated utility that incurs excess costs, or alternatively (b) by a duopoly utility structure that achieves lower costs at any output level. Assume further a single-product firm and subadditive costs. In Figure 1, $A_1(q)$ represents average incurred costs–that is, including excess costs--for the monopoly utility, while $A_2(q)$ is unit costs under duopoly structure. By assumption, $A_2(q) < A_1(q)$ for all q because of cost competition in the case of duopoly. The difference between the two cost curves is a measure of cost inefficiency from the regulated or publicly owned monopoly at each output q.

Given market demand $q(p)$, first-best price equals marginal cost, which is indicated by c_1. Unit cost c_2 represents the second-best price, i.e., that which minimizes allocative inefficiency subject to breakeven operation by the utility. But with only one utility, the cost locus A_2 is not attained. Rather, A_1 holds and the operative price is some third-best cost and price c_3--that which arises from monopoly production subject to both the breakeven constraint *and* cost inefficiency. The key question then becomes whether a duopoly in which neither firm is at full scale and where fixed costs are duplicated is more or less efficient than a full-scale but non-cost-minimizing monopoly utility. Unit cost and price under such a duopoly is indicated by c_4, which can lie above or below c_3.

This trade-off can be formalized as follows: Let minimum total costs be given by

$$C(q) = F + cq \qquad (1)$$

where F denotes fixed and sunk costs, and c is constant marginal cost. Actual incurred costs under monopoly exceed $C(q)$ and are given by

$$D_1(q) = (1 + \alpha)\, C(q) \qquad (2)$$

where α is the percentage excess cost.[2] Total incurred costs under duopoly are given by

$$D_2(q) = C(x) + C(q-x) \qquad (3a)$$

where x and $q-x$ denote the duopolists' respective outputs. For the present case of constant unit costs, total costs are invariant to the distribution of output between the firms. Hence this expression becomes simply

$$D_2(q) = 2F + cq, \qquad (3b)$$

We now wish to know, for given q, which production vector is more efficient--that based on a duopoly, or that under a non-cost-minimizing monopoly? Comparison of equations (2) and (3b) indicates that despite duplicative costs, duopoly is the lesser cost alternative so long as

$$2F + cq < (1 + \alpha)(F + cq) \qquad (4)$$

or

$$\alpha > F/(F + cq) \qquad (5)$$

That is, duopoly is more efficient whenever the percent of excess costs under monopoly exceeds the ratio of fixed to total costs. Thus, greater monopoly inefficiency and smaller fixed costs favor duopoly provision, and are more likely to do so as output itself increases. The reverse set of circumstances favors monopoly.

2. Benchmark Competition and Information Asymmetry

The alternative mechanism by which competition may operate is benchmark competition--where similar firms operate subject to regulation in different markets. The effect of such competition may be portrayed as follows: Assume initially that the firms are identical and that each is a regulated monopoly seeking to maximize its profits:

$$\pi_i = (p_i - c^*)q(p_i) \qquad (6)$$

Here p_i denotes the price set by firm i's regulator, $q(p_i)$ is the firm's demand curve (assumed identical across firms), and c^* is the minimum unit cost of production. Stated in terms of Figure 1, c^* is

[2] Excess cost may differ between fixed and variable costs, of course. The present model is easily modified to accommodate this possibility. By fixed costs, we mean any indivisible costs associated with production.

represented by the intersection of demand and $A_2(q)$, that is, c_2. This is common to all firms, known to them, but is not known to the regulator or public overseer. This latter fact would seem to preclude the regulator/overseer from enforcing c_2 Rather, there would seem to be informational rents conferred on the firm.

Note that in this stylized example, cost-of-service regulation is of little help. Under that technique, the regulator/overseer sets price at each firm's c_3, its incurred level of cost. The firm realizes no gain from cost conservation, incurs no loss from excess costs, and simply allows costs to rise.

In its simplest form, benchmark regulation addresses this incentive problem by setting each firm's price in accordance with the following rule:

$$p_i = \Sigma_{j \neq i} c_j/(n-1) \qquad (7)$$

That is, a firm's price is now determined by the average of the *other* firms' realizations on c. This severs the dependence of a firm's price on its own costs and instead creates an incentive to reduce its own costs. Shleifer (1985) has shown that the unique Nash equilibrium cost choice for such a firm is the minimum cost c^*. The reason is straightforward: Since each firm earns profit to the extent that it achieves costs below the average of others, each has an incentive to lower its costs and ultimately all costs are "competed" down to their minimum level.

For this benchmark competition to be effective in practice, several issues must be resolved: The regulator/overseer must credibly commit to these rules. Firm accounting practices must be sufficiently comparable, or at least any differences allowed for. And heterogeneity among firms' production processes, input costs, and demand conditions must be addressed. One proposed remedy for this last issue would identify characteristics that cause heterogeneity and then use regression techniques to purge firms' c_j's of such differences. In the limit, however, if firm heterogeneity dominates common characteristics, the utility of "benchmark" firms may be more as a source of some cost information, rather than as the basis for a specific regulatory or oversight formula.

Note, of course, that while direct competition would seem to create stronger cost incentives than benchmark competition, the latter has the distinct advantage of not compromising the realization of scale economies. That implies that either mode of competition might in principle result in greater cost efficiency. That relative effect, the comparison of each costs under simple monopoly, and the further incremental effect of public ownership vs. regulation are the key questions addressed below.

III. COMPETITIVE ELECTRIC UTILITIES: PUBLIC VS. REGULATED

Electric utilities in the U.S. are very numerous and diverse. The differ in size, structure, ownership, and competition. Here we focus primarily on competition in its two forms, and on ownership and regulation issues.

While infrequent, competition among U.S. electric distribution utilities is by no means unknown. Hellman (1972, p. 51) and Primeaux (1986, pp. 187-188) report that direct competition existed in 85 communities in 1939, declining to 49 cities in 1966 and to 27 by 1981. Two Department of Energy publications--*Typical Electric Bills* and *Electric Sales, Revenue, and Bills*--contain lists of jurisdictions with multiple electric service providers. The latter, for example, reports fully 110 cases where two (or in a few instances three) local distribution utilities operate in the same city or town. Most of these were simply cases where utilities had fixed and exclusive territories but operated in the same jurisdiction as another utility. Out of 3000 electric utilities in the U.S., these numbers are relatively small but nonetheless constitute a usable set of experiences for analysis.

The initial list of possible competitive utilities was complied from Hellman, Primeaux, and the DOE publications dating from 1976 into the early 1990s. All lists required updating, confirmation, and reconciliation to determine whether competition still existed and, if so, whether it was direct or benchmark competition. Moreover, in the case of true duopoly utilities, additional information on operations was sought. Since public information was not entirely adequate, a survey was sent to a total of 80 utilities in 40 jurisdictions.[3] These included all known cases of duopoly competition and others where doubt remained as to the nature of any competition. Initial responses plus follow-up contacts yielded a total of 46 completed questionaires. At least one response was secured from all jurisdictions

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[3] The assistance of the American Public Power Association with this survey is gratefully acknowledged. The result represents the most carefully established current compilation of competition in the electric utility sector.

where direct competition was believed to exist. Based on these returns together with public source information, 17 cities and towns were in fact determined to have direct distribution competition in the early 1990s. Other jurisdictions which had two utilities but lacked direct competition were categorized as having benchmark competition.

The 17 jurisdictions supporting direct competition--"duopoly utilities"--are listed in Table 1. In all cases one utility was publicly owned and the other a private regulated enterprise. As indicated there, in twelve cases existing customers could freely switch between electric power distributors on an on-going basis, while in five others such choice was limited to new residential and industrial users. Where switching was possible, customers were obliged in seven cases to notify their terminated supplier, and to wait from one to thirty days for the switch to be consummated. Apart from two with refundable deposits, no utility imposed a switching fee and only two had minimum stay requirements.

These provisions suggest relatively easy switching for customers in these cities and towns. It might seem surprisingly, therefore, that the median percentage of residential customers that actually do so in any year was only 0.5 percent, varying from near zero in Columbus, Ohio, to a maximum of just over six percent in Floydada, Texas.[4] One explanation, of course, is that one equilibrium to this competitive process is characterized by little or no customer switching as rival sellers optimally adjust. A more mundane possibility is suggested by survey responses indicating that some utilities' competitive efforts at attracting customers were stymied by regulatory or municipal boards that closely controlled pricing and related activities.

The survey also asked duopoly utilities about the operations side of their relationship with each other. Several utilities indicated that they had actual duplicate facilities--poles and wires--in their competitive areas. Perhaps the best known examples of such direct competition is Cleveland, Ohio. At the other extreme, five utilities indicated that they share poles, most on some contractual basis, although one professed to rely on a "gentlemen's agreement." Two of the five utilities sharing poles also

[4] The survey question on which these figures are based appears to have been answered in somewhat different ways. Present data are based on the best reconciliation of responses from one or both utilities together with available outside information.

reported that they also shared wires, while none did so with respect to drop lines to individual residences. In all but two cases utilities participated in some arrangement to buy and sell power between themselves, and in one case they jointly provided emergency services to customers affected by outages on either system.

Apart from these 17 cities and towns, approximately 70 other jurisdictions were found to have multiple distribution utilities within their borders where those utilities were constrained to fixed and exclusive territories. This arrangement obviously precludes customer choice, but as previously noted, the coexistence of a second utility operating in the same jurisdiction provides useful cost information to the regulator or public overseer without actually incurring duplicate facilities costs.

Of the approximately 3000 electric utilities in the U.S., nearly 2000 are publicly owned. Many of these are small purely distribution systems, although both large and vertically integrated publicly owned utilities certainly exist. Public ownership entails oversight by an independent agency or a committee of the governing board of the municipality which constitutes its "owner". The stated objective of such systems is in principle the same as for regulation of privately owned electric utilities--cost efficiency, service quality, and moderate prices. Both regimes also face the problem of informational limitations relative to the utility, which handicaps their ability to ensure these outcomes.

The effectiveness of competition of either form, as well as the ownership, in achieving desired cost targets is the empirical question to which we now turn.

IV. THE COST CONSEQUENCES OF COMPETITION AND PUBLIC OWNERSHIP

Several previous studies of competitive electric utilities have already been mentioned. Hellman relied upon case studies to infer that the existence of municipal utilities lowers the price charged by investor owned systems in the same communities. One of several studies by Primeaux (1977) compared costs in a matched sample of duopolies against monopoly utilities. Operating costs for competitive systems were found on average to be 11 percent less, a result interpreted as indicating that monopoly cost inefficiency outweighs any reduced realization of scale economies.[5] Nelson and Primeaux (1988) report that competition reduces average transmission and distribution costs for municipal systems, although elsewhere Nelson (1990) finds generation costs to be higher under competitive conditions.

While the data, methodology, and interpretations of these studies have been subject to criticism (e.g., Joskow and Schmalensee (1985), pp. 61-65), the results are nonetheless provocative. The present research pursues these questions using more detailed and reliable data and more sophisticated modeling techniques than in most past studies. Specifically, we estimate a cost function for local power distribution and test for the effects on costs from the various regime alternatives discussed above.

1. A Cost Function for Electric Power Distribution

Although our focus is on the distribution function, most utilities generate power as well. In order to allow costs to vary with each function and with each other--thus capturing economies of scale and vertical integration--we employ a multiproduct cost function, specifically, a quadratic form.[6] For present purposes, a baseline quadratic model would be specified as follows:

$$\begin{aligned} C = {} & \alpha_0 + \alpha_1\, DIS + \alpha_2\, COMP + \alpha_3\, DIS!COMP \\ & + \alpha_4\, GEN + \alpha_5\, GENSQ + \alpha_6\, DISSQ + \alpha_7\, DIS!GEN \\ & + \alpha_8\, FCGEN + \alpha_9\, PURCH + \alpha_{10}\, W + \alpha_{11}\, X \qquad (8) \end{aligned}$$

Total utility costs C are defined as the sum of costs from transmission, distribution, generation, and/or purchase of power, as well as overhead, depreciation, and an imputed capital charge. The latter is calculated as the price of capital multiplied by net electric plant. The price of capital for investor-owned utilities is the weighted average cost of common stock, preferred stock, and long-term debt. In the

[5] One specification suggested that the differential is not constant, but rather grows with utility size. Emmons (1993) examines prices, reporting that competition lowered prices charged by private electric utilities but not the prices of their publicly owned rivals in 1930. Competition lowered neither in 1942, a result Emmons attributes to the equalizing effect of yardstick and potential competition.

[6] The alternative translog cost function does not handle zero values as readily as does the quadratic. Non-generating utilities, of which there are many in these data, have zero values for output and related variables. For this reason the quadratic has often been used in such estimations. See, for example, Roller (1990) and Kaserman and Mayo (1991).

case of publicly owned utilities, it is the weighted average cost of debt and certain minor capital-like items unique to these systems.[7]

The key output variable is mwh of power distribution *DIS*, that is, sales to final customers and to the resale market. Previous discussion has hypothesized that both direct and benchmark competition strengthen incentives for cost reduction, but noted that direct competition may also result in duplication of costs. To allow for both possibilities, the cost function includes two additional terms--a fixed effects term *COMP*, defined as unity for all utilities in competitive environments, zero otherwise, together with its interaction with distribution output, denoted *DIS*!*COMP*.[8] *COMP* shifts the intercept of the cost curve and should capture the added costs of duplicate facilities. The interaction term, by contrast, permits competition to affect operating costs.

The majority of utilities also generate power, and for them mwh of generation (*GEN*) represents a second output. Both outputs are included in quadratic forms as well (*GENSQ*, *DISSQ*). This cost function also requires the interaction term between the two outputs (*DIS*!*GEN*), which conveniently captures any economies or diseconomies of vertical integration between the stages of production (Kwoka, 2002). A variable measuring mwh of purchased power (*PURCH)* is included to control for the costs of *non*-generated power. The fixed effects term *FCGEN* allows for any fixed costs specific to generation. All of these variables together with those represented by a vector of factor costs *W* and a vector of other control variables *X* are identified and data sources provided in Table 2.

2. Initial Results

The data base utilized in this study consists of 507 utilities accounting for over 90 percent of all electric power sold in 1989. Eighty-three of the 507 utilities face competition--fourteen actual

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[7] These are "investment by municipality" and "constructive surplus/deficit," representing capital and related transfers from municipalities to their publicly owned systems. Consistent with other evidence, the cost of capital is significantly less for publicly owned utilities than for IOUs.

[8] Direct vs. benchmark competitors will be distinguished in later analysis.

duopolies and 69 cases of benchmark firms.[9] The results of estimating the cost function in equation (8) appear in Table 3. All specifications achieve a high degree of explanatory power, with R^2s of nearly .97. Most variables are correctly signed and statistically significant. Before addressing the impact of competition, we will briefly summarize the results on other variables.

First with respect to distribution and generation outputs, all terms but one have the correct sign and are statistically significant.[10] The coefficient estimates on *DISSQ* and *GENSQ* confirm convexity of the cost function, that is, diseconomies of scale eventually set in for both outputs. The negatively signed interaction term *DIS***!***GEN* implies cost complementarity between generation and distribution, a key condition for economies of vertical integration.[11] The term representing power purchases is statistically significant, while that for generation-specific fixed costs is not.[12]

The variables denoting the type of generation capacity emerge with the expected signs, although not all coefficients are significant. Reliance on nuclear power (*NUCLEAR*) and peaking power (*PEAKING*) is associated with higher cost, while greater use of hydro power (*HYDRO*) lowers it.[13] The three input prices--*PRFUEL*, *WAGE*, and *PRCAP*--are all positively signed and significant (or nearly so) in their interactions with output but not in their linear forms.[14] The coefficients on the variables representing high-voltage power, average customer size, and customer density all confirm

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[9] Not all of the competitive utilities identified in Table 1 are in this data set, due to the lack of complete data on them.

[10] Although *DIS* is negatively signed, it is insignificantly different from zero. Even if significant, however, the overall effect of output on costs is a function of other terms that are interacted with *DIS*.

[11] Cost complementarity is not by itself a sufficient condition, but economies of vertical integration have been established for these utilities (Gilsdorf, 1994; Kwoka).

[12] This does not imply that there are no generation-specific fixed costs, since those are also represented in the terms for capacity type and fuel price.

[13] The omitted category is conventional steam generation capacity. The peaking category is actually listed as "other," but it largely consists of turbines and other technologies held to serve peak demand.

[14] Linear price terms simply shift the intercept of the cost function. Interaction terms with output more plausibly reflect the cost effects of of higher input usage but their inclusion greatly increases collinearity among the variables.

expectations: High-voltage production (*HIVOLT*) reduces cost since it requires little or no voltage reduction and involves smaller line losses. Greater average customer usage (*USAGE*) similarly lowers costs, by conserving on administrative and service costs. Finally, higher customer density (*DENSITY*) is associated with cost reduction, confirming earlier discussion about its impact on both facilities costs and operations costs of distribution utilities.

More to the point, one central issue of this study–that competition matters--is confirmed by these results: The fixed effects term *COMP* is positively signed and significant at 10 percent in a one-tail test, implying that competition results in the lesser achievement of scale economies and therefore the duplication of fixed costs. Taken at face value, its magnitude--$27.4 million--represents a 10.5 percent increase in the mean total cost for utilities in the data base. But as hypothesized, competition is associated with a reduction in incurred operating costs. The interaction term *DIS!COMP* is negative and highly significant (t = 4.39). Evaluated at mean output, this represents a $31.9 million cost reduction, or 12.3 percent of total cost, due to competition. Netting increased fixed and reduced operating costs and holding all else constant, the average utility has total costs 1.7 percent less when operating in a competitive setting rather than a monopoly. This is a modest, but certainly nontrivial and plausible, effect.

The fact that competition produces a net cost advantage at sufficiently large output levels corroborates the prediction of the model in Section II(A). There it was also shown that a duopoly competitor is more likely to save costs at larger output by virtue of averaging facilities costs over more units. There is evidence of this effect in the present results as well. The estimated magnitudes of the fixed and variable cost effects permit determination of the "crossover" point--the output at which net cost savings first emerge. That point is at 4.1 million mwh of distribution output (27.4 million mwh, divided by 6.76). Of 83 competitive utilities, 49--or nearly 60 percent--exceed that threshold, compared with only 15 percent of the 424 monopoly utilities in the data base. It seems clear that competition is more prevalent precisely where the underlying cost structure implies it is viable and advantageous.

It should be noted that some competitive utilities face competition in only a portion of their service territory, whereas others confront it for most of their customers. To determine whether utility costs are affected differently under these circumstances, we incorporate a variable for the percent of each utility's customers that reside in its competitive region. This variable is statistically insignificant, with a t-value of about .20. This suggests a spillover effect of some magnitude: Even a modest degree of competitive contact results in widespread cost reductions.

3. Effect of Type of Competition

The results so far are based on the simple *COMP* variable without distinction between types of competition. That model is now generalized to allow for differences in the cost effects of duopoly competition and benchmark competition, both relative to conventional monopoly. Accordingly, we define fixed effects terms for direct or duopoly competition (*DIRECT*) and for benchmark competition (*BENCH*), together with their respective interaction terms with output. It should be noted that this is one of very few tests of the effect of benchmark competition in the literature.

The results of this estimation are reported in column (b) of Table 3. As is evident, both forms of competition lower costs relative to regimes lacking competition altogether, but the effect of benchmark competition is now rather striking: Presumably by conveying information about cost efficiency, such a firm clearly leads to lower cost of the other firm in the market. Duopoly operating costs are lower than under monopoly, with *DIS•DIRECT* statistically highly significant with a t = 2.55. While the term *DIRECT* suggests that fixed costs under duopoly may be higher, this estimate does not achieve true statistical significance (t = 1.24). In all important respects, these results mirror those found overall for competitive utilities and broadly confirm our hypothesis that while direct competition may entail higher fixed costs, it conserves on variable costs.

There is a further testable hypothesis in the case of benchmark competition. Since such competition does not entail duplicative facilities costs or otherwise impede the realization of scale economies, its effect, if any, should manifest itself in operating cost reductions. These predictions are confirmed by present evidence. The fixed effects term *BENCH* is positive but clearly statistically insignificant, with a t = 0.95. By contrast, the coefficient on *DIS*!*BENCH* is negative and highly significant (t = 3.76). Benchmark competition appears to be quite effective in reducing costs and in particular operating costs.

Remarkably, the magnitudes of cost effects resulting from benchmark competition do not differ greatly from those from facilities duopoly. The rates of variable cost savings--the coefficients on *DIS*!*DIRECT* and *DIS*!*BENCH*--are very similar, and the fixed cost terms, taken at face value, differ only by factor of two. In both cases statistical tests indicate that the effects of direct competition--higher fixed cost and lower variable costs--exceed the effects of benchmark competition. Nonetheless, this evidence clearly supports the proposition that benchmark competition–through the mechanism of superior information to the oversee--serves as a potent, if not quite perfect, substitute for the direct effect from an actual rival in the market. This is an especially important discovery since benchmark competition entails none of the scale economy sacrifice that accompanies an actual competitor.

4. The Effect of Public vs. Private Ownership

The 83 competitive electric distribution utilities differ in another important respect that needs to be addressed: Fifty-one of them are regulated investor-owned utilities, the remaining 32 publicly owned. Extensive literatures maintain that both public ownership and regulation afford opportunities for non-cost-minimizing behavior, but the magnitude of any inefficiency and the impact of competition on that magnitude need not be identical between the two regimes. In order to avoid imposing such uniformity across ownership mode, we first define a fixed-effects variable to distinguish cases of public ownership from private ownership. Then we create interaction terms between it and the four variables representing duopoly and benchmark competition and also with the output variables themselves. All are included in an augmented cost function that is estimated and reported in column (c) of Table 3.

The impact of competition is shown to differ strikingly between the two types of utilities. The effects of direct and benchmark competition for regulated private systems are captured by the same variables as previously employed: *DIRECT, DIS*!*DIRECT, BENCH,* and *DIS*!*BENCH.* The estimated coefficients are somewhat larger and more highly significant than those reported in column (b), but the effects have the same signs and a similar pattern of magnitudes--higher fixed costs and lower variable costs, and both somewhat greater for duopolies than in the case of benchmark competitors.

These same four variables when interacted with *PUB* serve to reflect any differences in the cost effects for publicly owned competitive utilities relative to all other competitive systems. The results in column (c) clearly show that such differences exist and are significant. The coefficients on all four variables distinguishing publicly owned utilities are of opposite sign from, and have absolute magnitudes very similar to, the corresponding variables for all direct and benchmark competitors. That is, they negate the effects on cost just reported for privately owned utilities. More specifically, a test of the coefficients on *DIRECT* and *PUB*!*DIRECT* cannot reject the hypothesis of equality (t = 3.78), nor can analogous tests on the coefficients on *BENCH* and *PUB*!*BENCH* (t = 1.76) and on the coefficients on *DIS*!*BENCH* and *PUB*!*DIS*!*BENCH* (t = 2.15). Only the coefficients *DIS*!*DIRECT* and *PUB*!*DIS*!*DIRECT* appear to be significantly different (t = .77).

These sums indicate that competition has little incremental effect in the case of publicly owned utilities. Rather, all publicly owned systems achieve similar costs whether facing competition or not. What was previously found to be the effect of competition was therefore due to the changed behavior of private utilities only. It is only in the case of privately owned and regulated utilities that competition is necessary in order to fully realize lower costs. Put more positively, regulation can be improved by the appropriate introduction of competition, whereas costs are not further lowered by competition in the case of public ownership.

An important question is whether these lower costs for public systems–for *all* public systems, whether subject to competition or not--are equal to the higher costs of private monopoly or to the lower costs achieved by private utilities facing competition. Recalling that the competition variables for publicly owned utilities essentially drop out, we therefore look to other evidence concerning the relative distribution costs of (any and all) publicly owned utilities and privately owned systems. The relevant results are also reported in column (c) of Table 3. Fixed costs for public systems, represented by the fixed effects variable *PUBLIC*, appear somewhat greater, but the statistical significance of the difference (t = .88) is doubtful. But variable costs are clearly lower, with the coefficient on *PUB!DIS* having a t-statistic of 2.91.

By themselves, these suggest lower costs for publicly owned utilities, but these comparisons are against the omitted category of utility, which is privately owned systems subject to regulation but not to competition. To repeat, relative to those, publicly ownership achieves significantly lower costs. Whether those costs are as low as regulated *and competitive* private utilities requires comparison of the coefficient of *PUB•DIS* with the coefficients on *DIS•DIRECT* and *DIS•BENCH*. The latter two coefficients measure the effect of competition in either form in the case of private, regulated utilities. The absolute value of the public ownership effect (24.8) is actually a bit larger—but not significantly so--than either of the two variables measuring the effect of competition on regulation (17.9 and 8.19, respectively). This simple comparison establishes that the costs achieved by public ownership itself are the same as what is achieved by a combination of competition *and* regulation. This conclusion provides substantial support for public ownership in circumstances where perfect competition cannot be attained and where regulation cannot be supplemented by direct or benchmark competition.

V. CONCLUSIONS

The proposition that competition affects cost may seem scarcely worth stating, much less proving. But this paper demonstrates four things not previously recognized, or at least not established empirically: First, cost competition may produce net benefits even when some scale economies are sacrificed. Secondly, competition is beneficial both in the form of direct rivalry as well as through benchmark competition. Third, competition–of the benchmark type–reduces costs even for a utility already subject to regulation as a natural monopoly. And fourth, costs under public ownership are not further reduced by competition, implying that public ownership is by itself a fully effective method of cost minimization.

From a policy perspective, this study underscores the enormous power of competition to impose cost discipline, even relative to other institutions such as regulation which are directed at the same objective. Direct competition is clearly useful in this regard, but benchmark competition is surprisingly effective as well. Conveniently, the latter does not require multiple sellers and the possible sacrifice of scale economies. A further policy implication concerns public ownership. While often suspected of inferior cost performance, the evidence here shows that publicly owned utilities achieve costs comparable to those under competition. As between those two regimes, public ownership appears more successful by in controlling costs by itself, though regulation buttressed by benchmark competition achieves a similar result.

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TABLE 1
CITIES WITH MULTIPLE ELECTRIC UTILITIES AND CUSTOMER CHOICE

	Customer Choice		Terms of Switching							
City/Town	New Only	New & Existing	Advance Notice	Charge	Waiting Time	Minimum Stay	Customer Switching Per Year (%)	Utilities Poles	Share: Wires	Power Purchase Agreements
Alexander City, AL[1]	X									
Bay City, MI[2]	X									
Bushnell, IL		X	Both	None	2 Days	12 Months	0.84	N	N	Y
Cleveland, OH		X	Both	None	2 Weeks	None	0.66	N	Y	Y
Columbus, OH			Both	None	30 Days	12 Months	0.03	Y	Y	Y
Culpepper, VA		X	Both	None	7-30 Days	None	0.08	Y	N	Y
Dowagiac, MI		X	Both	Deposit	7-30 Days	None	0.10	Y	N	Y
Duncan, OH		X	Both	Deposit	1 Day	None	5.92	N	N	N
Floydada, TX		X	New	None	3 Days	None	6.19	N	N	Y
Greer, SC	X									
Houma, LA	X									
Lubbock, TX		X	New	None	3 Days	None	2.40	N	N	Y
Newton Falls, OH		X	New	None	7-30 Days	None	1.30	N	N	N
Paris, KY		X	New	None	1 Day	None	0.27	Y	N	Y
Piqua, OH		X	Both	None	1-2 Weeks	None	0.11	N	N	Y
Poplar Bluff, MO	X									
Traverse City, MI[3]		X	New	None	3-7 Weeks	None	0.22	Y	N	Y

Notes: 1 = Minimum power usage required to switch. Only industrial customers do so.
2 = Only areas contiguous to Bay City; City firm purchased IOU's equipment inside city limits in 1992.
3 = 1994 Agreement between city and IOU effectively ceased competition.

TABLE 2

Variable Names, Definitions and Data Sources

NAME	**VARIABLE (SOURCE)**
Output-related	
DIS	Distribution output in mwh (A, B)
DISSQ	Square of DIS
GEN	Generation output in mwh (A,B)
GENSQ	Square of GEN
DIS · GEN	Product of DIS and GEN
FCGEN	Fixed effects term, equals 1 for utilities with GEN > 0
PURCH	Purchased power in mwh (A, B)
NUCLEAR	Percent capacity that is nuclear (A, B)
HYDRO	Percent capacity that is hydro (A,B)
PEAKING	Percent capacity designed to serve the peak (A,B)
Cost-related	
PRFUEL	Weighted average price of fossil and nuclear fuel in $/mwh (A,B)
GEN · PRFUEL	Produce of GEN and PRFUEL
WAGE	Average manufacturing wage in utility's state, $/yr. (C)
DIS · WAGE	Product of DIS and WAGE
PRCAP	Weighted average price of capital, % (A,B)
DIS · PRCAP	Product of DIST and PRCAP
HIVO	Percent of sales represented by high-voltage uses (A,B)
USAGE	Average residential usage of electric power, mwh/customer (A,B)
DENSITY	Number of residential customers divided by miles of distribution lines (A,B)

Competition-related

COMP	Fixed effects term, equals 1 for a utility facing a competitor (E,F,G)
DIS · COMP	Product of DIS and COMP
DIRECT	Fixed effects term, equals 1 for a utility facing a direct (duopoly) competitor (E,F,G)
DIS · DIRECT	Product of DIS and DIRECT
BENCH	Fixed effects term, equals 1 for a utility facing a competitor in adjacent territory in same jurisdiction (E,F,G)
DIS · BENCH	Product of DIS and BENCH

Ownership-related

PUBLIC	Fixed effects term, equals 1 for publicly owned utility (B)
PUB · DIS	Product of PUBLIC and DIS
PUB · GEN	Product of PUBLIC and GEN
PUB · DIS · GEN	Product of PUBLIC and DIS · GEN
PUB · DIRECT	Product of PUBLIC and DIRECT
PUB · DIS · DIRECT	Product of PUB and DIS · DIRECT
PUB · BENCH	Product of PUBLIC and BENCH
PUB · DIS · BENCH	Product of PUBLIC and DIS · BENCH

Sources:

A *Financial Statistics of Selected Investor-Owned Electric Utilities 1989*, Department of Energy

B *Financial Statistics of Selected Publicly Owned Electric Utilities 1989*, Department of Energy

C *Statistical Abstract of the United States*, Bureau of the Census

D Department of Energy, Form 861

E *Typical Electric Bills*, Department of Energy

F *Electric Sales, Revenues, and Bills*, Department of Energy

G Author’s survey

Unmarked variables are constructed

TABLE 3
Regression Results on Utility Costs
(t-statistics in parenthesis)

Variable (Scale)	(a)	(b)	(c)
Competition-Related			
COMP (10^6)	27.4		
	(1.27)		
DIS · COMP	-6.76		
	(4.39)		
DIRECT (10^6)		52.6	544
		(1.24)	(3.83)
DIS · DIRECT		-6.29	-17.9
		(2.55)	(3.83)
BENCH (10^6)		22.6	72.6
		(.95)	(1.88)
DIS · BENCH		-5.96	-8.19
		(3.76)	(4.11)
Ownership-Related			
PUBLIC (10^6)			20.9
			(.88)
PUB · DIS			-24.8
			(2.91)
PUB · GEN			7.14
			(.58)
PUB · DIS · GEN (10^{-6})			1.97
			(3.51)
PUB · DIRECT (10^6)			-556
			(3.58)
PUB · DIS · DIRECT			39.6
			(.39)
PUB · BENCH (10^6)			-72.9
			(1.50)
PUB · DIS · BENCH			10.9
			(1.34)
Output-Related			
DIS	-12.5	-12.5	-8.77
	(1.42)	(1.34)	(.94)
DISSQ (10^{-6})	2.29	2.29	2.03
	(6.45)	(6.35)	(5.62)
GEN	21.2	19.8	14.9
	(2.88)	(2.68)	(1.88)
GENSQ (10^{-6})	1.73	1.77	1.63
	(4.76)	(4.81)	(4.42)

Variable (Scale)	(a)	(b)	(c)
DIS · GEN (10^{-6})	-3.89	-3.92	-3.46
	(5.45)	(5.42)	(4.81)
FCGEN (10^6)	-16.5	-16.0	-8.99
	(.85)	(.82)	(.46)
PURCH	38.1	37.6	48.9
	(5.52)	(5.39)	(6.48)
NUCLEAR (10^6)	428	423	422
	(7.09)	(6.94)	(7.22)
HYDRO (10^6)	-25.9	-23.3	-25.9
	(.84)	(.77)	(.86)
PEAKING (10^6)	38.6	38.7	31.6
	(1.35)	(1.35)	(1.14)
<u>Cost-Related</u>			
PRFUEL (10^6)	.275	.285	.111
	(.53)	(.55)	(.22)
GEN · PRFUEL	.835	.855	1.01
	(5.16)	(5.17)	(5.83)
WAGE (10^6)	-11.2	-12.3	-8.36
	(1.15)	(1.25)	(.88)
DIS · WAGE	2.95	3.00	2.01
	(3.39)	(3.41)	(2.21)
PRCAP (10^6)	-60.3	-69.9	-22.0
	(.36)	(.41)	(.13)
DIS · PRCAP	105	111	118
	(1.85)	(1.79)	(1.86)
PCTHIVO (10^6)	-47.6	-47.9	-32.0
	(1.58)	(1.58)	(1.09)
USAGE (10^6)	.856	.841	.808
	(2.02)	(1.97)	(1.96)
DENSITY (10^4)	6.66	6.70	8.08
	(.80)	(.80)	(1.00)
CONSTANT (10^6)	96.4	102	59.0
	(1.94)	(2.02)	(1.08)
R^2	.967	.967	.970
F^2	675	608	498

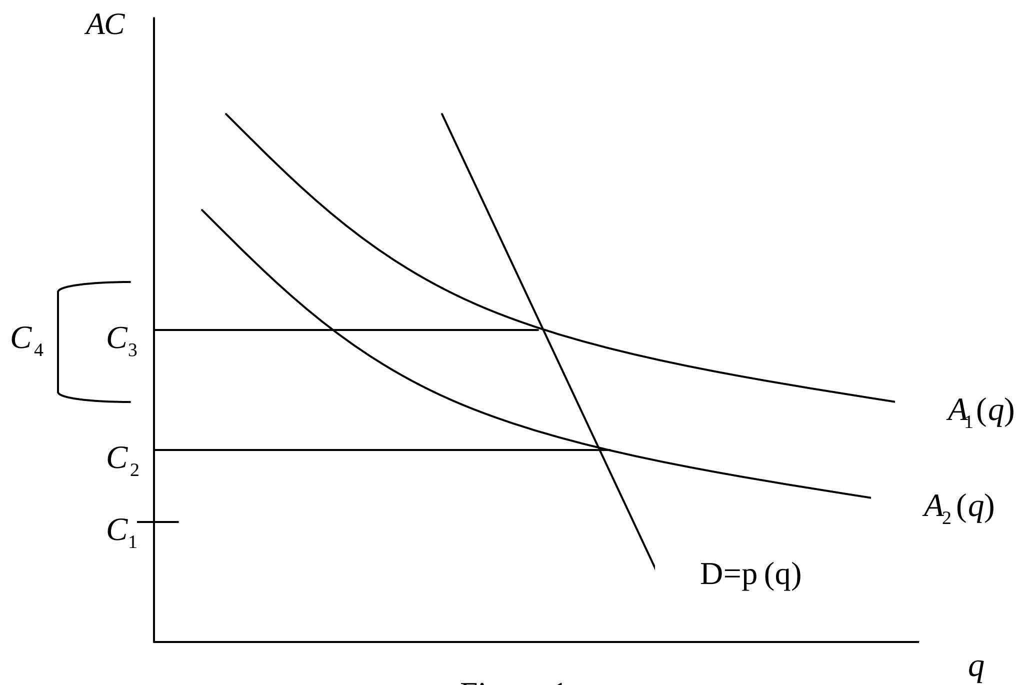

Figure 1