The Relative Economic Efficiency of Private versus Municipal Waterworks in the 1890s

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A controversy that has long raged in the political economy of American cities is whether public utilities are best provided by utilities run by government or by private companies. This controversy became important toward the end of the nineteenth century during the Progressive era. An integral part of the Progressive movement was the crusade for municipal reform, which included the demand for municipal ownership of public services. The justification for such a course of action was provided by members of the "new" school of political economy, comprised of American political economists such as Richard T. Ely, Henry C. Adams, John R. Commons, Edmund J. James, and E. R. A. Seligman who rejected *laissez faire* in favor of a more activist role for government in the economy. Despite areas of disagreement, most of these economists favored municipal ownership of public utilities [8, pp. 221-28].

A special problem posed by utilities, compared to other businesses, is their tendency to be monopolies. Henry C. Adams associated this with declining average costs and argued that unregulated, small-scale competition would deny society the advantages that a monopoly would enjoy in these circumstances. Utilities are also likely to have customers with low elasticity of demand and large consumer surplus, making the potential for abusive practices

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particularly worrisome. The issue faced by Progressive reformers was summed up by Edward W. Bemis in 1899:

> Every one concedes that soon half of the population of this country will be living in cities of over 8,000 inhabitants, and that to every one of these cities the supply of water, street railways, electric light, gas for fuel and lighting purposes, and the telephone at the command of every one, if not in every home, will have become vital necessities. Nearly everyone is also ready to concede that each of these industries partakes of the character of a monopoly. . . . Three great questions now confront us: Shall we have public regulation, or public ownership and operation? If the former, what shall be the nature of the regulation? If the latter, what are the dangers to be avoided? [4, p. v]

Much of the concern expressed over the issue of utility ownership dealt with the effect the different forms of ownership would have on some measure of a utility's economic performance. An important issue was the relative efficiency of municipally owned utilities compared to privately owned utilities. A closely related issue was whether service was cheaper from utilities under public ownership, and, if so, could the difference be attributed to greater efficiency or to subsidization.

In this paper we examine the relative performance of privately owned and publicly owned waterworks during the Progressive era to answer questions of efficiency, pricing, and return on capital. A brief history of public waterworks is presented below. This is followed by a description of the data and presentation of a model used to examine these issues. An empirical estimation of the model concludes the paper.

THE HISTORY OF PUBLIC WATERWORKS IN THE US

As waterworks developed in the US, the relative importance of public and private ownership fluctuated. Central urban waterworks did not appear in this country until 1652 (in Boston), and by 1800 there were but sixteen, only two of which were south of the Potomac [3, pp. 11-14]. The rapid urbanization of the United States in the nineteenth century focused attention on the problems of preventing epidemic disease and of providing fire protection in urban areas. The adoption of mechanical pumps greatly facilitated the provision of clean water from a central supply source [1]. Cities either granted a monopoly franchise to a privately owned company or provided the service directly. In 1800 all of the sixteen existing plants were privately owned. By 1825, five of the thirty-two existing waterworks were publicly owned, but by 1875, 54 percent of the 422 waterworks were publicly owned. State-mandated limits to municipal borrowing and the availability of private capital led the private sector to dominate the great waterworks building boom that occurred in the late nineteenth century, and the proportion of publicly owned waterworks declined to 43 percent by 1890. After 1890 the tide again turned. By 1899 there were 3,326 waterworks in existence in the United States slightly over half of which were owned by municipalities [3, pp. 15-21].

The constant tension between the forces advocating public ownership and those advocating private ownership of waterworks is well illustrated by the case of Houston, Texas. In 1876, the City Council first moved to establish a public waterworks. Because of financial difficulties, the project was offered for open bidding to private interests. Two years later, the Council awarded the project to an experienced New York engineer who constructed an adequate facility in less than a year. He then sold the plant to local interests and withdrew from its operation [15, p. 144].

Although the community was at first satisfied with the facility, problems developed. After a "fire consumed an important cotton seed mill in 1886, while firemen stood by helplessly because the hydrants were dry," [15, p. 90] a reform measure was enacted that increased municipal control over the water company's operations, but the system tragically broke down again in 1894 under similar circumstances [15, p. 144]. A new investigation was undertaken, this time fueled by demands for a municipal takeover. Consumers complained about the level of prices while the company defended itself by noting the increasing investment that was being made in facilities. Fire insurance underwriters criticized both the company and the lax regulation of the local government [15, pp. 144-45].

The argument for municipal ownership was further strengthened with the contention that Houston's growing budget deficit could be reversed were the city to become a profitable supplier of water (and electricity) rather than just a major customer (10 percent of the city budget in 1892). This movement for public ownership was stopped abruptly by the panic of 1893 and by a Texas Supreme Court decision that devastated the city budget by making special tax assessments against urban homesteads unenforceable. The city then attempted to regulate the water utility through confrontation. In an attempt in 1899 to prod the water utility into providing better service at lower rates, the city withheld half of its payments due and created a permanent waterworks committee to act as a public watchdog [15, p. 162]. The period of confrontation continued into the twentieth century. Finally, after a series of bitter court battles, the city purchased the water utility from the original owners in 1906 [15, pp. 197-99].

Municipal purchases of private waterworks occurred in other cities, and this, together with the construction of new municipally owned waterworks, increased the proportion of waterworks that were publicly owned. Between 1890 and 1897 over 110 waterworks changed from private to public hands, while fewer than ten switched the other way. Publicly owned plants tended to exist in larger cities, so that approximately two-thirds of the urban population was served by municipally owned water utilities. Of the fifty largest cities in the United States only nine were served by private water utilities [3, pp. 26-27]. These figures demonstrate the viability of public ownership of waterworks and the political success that Progressive reformers were realizing.

PUBLIC VERSUS PRIVATE OWNERSHIP

The issue of whether society is better served by enterprises that are publicly owned or by those that are privately owned involves theoretical and ideological controversies about which there is still considerable disagreement.[1] One view expressed in the late nineteenth century held that any operation established and run by political appointees must be inefficient:

> The "shame of the cities," as Lincoln Steffans, the muckraker, termed it, went back to the post-Civil War years. The fact was that the organization of city government in the U.S., with its dispersal of power and responsibility among a mayor, council, and numerous independent boards and commissions, was an invitation to machine politics. City government lacked the cohesion and concentration of authority to govern. [9, p. 581]

The argument against public ownership also emphasizes the differing incentives that enterprise managers, as agents for owners, face under the different property-rights arrangements:

> [the] high cost (if not impossibility) to individual owners of public enterprises (that is, citizen-taxpayers) of transferring their ownership shares inhibits the capitalization of future market consequences into their current property right in the firm. The incentive of citizen-owners in this institutional setting to detect and police inefficient operating behavior is thus mitigated. [7, p. 397]

In terms of relative efficiency, this argument implies that the public firm will have higher production costs at similar levels of output than will the private firm.

The Progressive reformers rejected precisely this contention. They argued that given reforms in the civil service system, there was no inherent tendency for private managers to be superior to public managers, even considering possible differences in the incentives they faced. Edmund James noted that

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[1]Controversy over plans to sell Conrail is a recent example. There have been studies of Australian airlines, British and US electric utilities, Canadian railroads, US hospitals, Swiss garbage collection, and US retail liquor stores. For a summary see [14]. Studies of US water utilities include [6] and [7].

whereas the property rights argument might be valid for small, owner-managed businesses, it did not necessarily hold where there was separation of ownership and control in the privately owned firm [8, p. 226].[2] In addition, the desire of public managers to maintain occupational mobility in their careers could provide an incentive for them to operate their enterprise efficiently.

M. N. Baker, editor of *Engineering News* and compiler of the *Manual of American Water-Works*, a compendium on existing facilities, was perhaps the most knowledgeable observer of the American waterworks industry at the turn of the century. Baker authored a chapter on waterworks in the book analyzing municipal monopolies edited by Edward Bemis in 1899. Although he was a proponent of municipal ownership and municipal reform, his discussion of the relative advantages and disadvantages of municipal versus private ownership was balanced, and he was realistic about the likely persistence of both forms of ownership.

Baker argued that the success of private ownership rested fundamentally on the design of the franchise:

> If a franchise is a valuable privilege granted by a city or town, and if its acceptance carries with it obligations on the part of the grantees, it follows that these obligations should be commensurate with the privileges. [3, p. 32]

Baker felt that the term of a franchise should be inversely related to the degree of control retained by the city over the franchisee's rates and standards of service. In no case should a franchise be longer than twenty-five years. The rates charged by a private company were to be sufficient to permit a reasonable rate of return, and accounts were to be open to the public to instill confidence in the integrity of managers. Public supervision of the operation of the private service was crucial since "the strongest safeguard of either public or private rights is the knowledge that no pains will be spared to determine and enforce them." [3, p. 35]

The primary advantage of private ownership to Baker "is that under it every endeavor is made to conduct the works in the most prudent and economical manner, in order to insure the greatest possible return on the capital." [3, p. 40] Baker argued that the cost of materials (primarily fuel) would be identical under both forms of ownership, but that lower wages and longer hours in the private sector would combine to keep labor costs lower for privately owned plants. The relative absence of political pressures in privately owned waterworks improves efficiency, primarily because subsidization of

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[2]James thus anticipated Berle and Means [5].

water rates from other revenues is less likely and because of lower turnover in top management. Baker found empirical justification for this position from the fact that 54 percent of municipal waterworks had changed superintendents in the previous five years, while only 38 percent of private waterworks had so changed [3, p. 43]. He disapprovingly noted the practice of some municipally owned waterworks of subsidizing the cost of water provision from general tax revenues.

As a reformer, Baker apparently did not view the political problems then existing in publicly owned waterworks as inherent in that form of ownership:

> There is no reason why a municipality cannot build and operate water-works as cheaply as a company, and it can almost invariably raise the necessary capital at a lower rate of interest. If a municipality does not succeed as well as a company in these particulars, it is due to political favoritism, corruption, incompetency, or negligence on the part of the public officials, more largely than to anything else. [3, p. 47]

He argued that municipally owned waterworks had an important economic advantage over private waterworks in access to capital markets "because the whole assessable property of the town is generally liable for the payment of interest and principal, while a company can give security only on the works." [3, p. 45] He also claimed private companies tended to over-capitalize by borrowing to build the plant as well as issuing stocks on which dividends were paid.

Baker does not argue directly that municipally owned waterworks were more efficient than privately owned ones; he maintains rather that they *could* be more efficient, presumably following municipal reform. The entire debate would, of course, have benefited from empirical analysis of the possible differences in efficiency resulting from the two types of ownership. Two of Baker's contentions about the differences between municipal and private utilities are potentially testable. The first is that municipalities were likely to subsidize rates (thus potentially concealing inefficiency). The second is that municipal utilities would have lower financing costs and are less likely to be over-capitalized than private utilities. These empirical issues are addressed in the sections which follow.

THE DATA

Concern over the issues of utility ownership led the National Association of Officials of Bureaus of Labor Statistics to pass a resolution at their Twelfth Annual Meeting in 1896 urging a study of "municipal ownership of water, gas, and electric-light plants. . . .not to be considered for or against municipal ownership, but for the purpose of ascertaining all facts bearing upon this question." [16, p. 5] That resolution led to the *Fourteenth Annual Report of the Commissioner of Labor, 1899*. Our empirical work is based on the section of the *Report* that presents the results of a survey of water utilities. Of the 1,539 private plants in operation, 375 (24 percent) provided sufficient information to be included in the *Report*. Of the 1,787 municipal plants, 659 (37 percent) were included. Those plants included in the *Report* accounted for a larger proportion of total investment than their numbers would indicate and included 44 percent of the investment then in private plants and 90 percent of the investment in municipal plants. The data collected included information on capital invested, output, technology, costs, revenues, and profits. Anonymity was guaranteed and no identifying information, such as the location of the utility, was provided.

For our empirical work, we chose thirty-two publicly owned and thirty-two privately owned plants from the *Report*. Our objective was to control for factors affecting economic performance by selecting pairs of plants that were similar, especially in terms of their scale of output. Data was collected on output (divided into private sales by meter, private sales by contract, and sales to the municipality), the various categories of cost (including the components of operating costs and estimated depreciation, but excluding interest expenses), source of water, technological variables (year the plant was constructed, distance from source of water to pumps, existence of a steam engine, and diameter of mains), total investment in mains and plant, and income (by the same categories as sales). The sample includes both municipal and private firms with strictly comparable technology and scale of production.

SUMMARY STATISTICS

Table 1 provides a comparison of measures of univariate summary statistics for municipally owned and privately owned plants covering such characteristics as cost, investment, output, revenues, and rates of return. Advocates of private ownership argued that municipally owned plants would have higher production costs. Reformers such as Baker argued that labor costs would be higher for municipally owned firms, but capital costs would be lower. Although, as shown in the table, there were differences between publicly- and privately owned companies in mean total costs, total operating costs, average total costs, and average operating costs, the differences were not statistically significant. In addition, those variables measuring the proportion of costs going to pay for various inputs (salaries, wages, fuel, and maintenance) show no statistically significant differences between ownership types.

Table 1
INDUSTRY CHARACTERISTICS--SUMMARY STATISTICS

Variable	Ownership	Mean	Standard Deviation	P-Value for t-test of equal means	P-Value for F-test of equal variances
COSTS					
Total Costs	Municipal	27,957	49,924	0.78	<0.01
	Private	33,202	92,738		
Operating Costs	Municipal	14,580	27,740	0.63	<0.01
	Private	20,805	68,183		
Total Cost per million gals.	Municipal	111.20	103.70	0.79	0.23
	Private	103.20	128.90		
Operating Cost per million gals.	Municipal	66.80	66.80	0.78	0.49
	Private	61.70	76.00		
COST SHARES					
Salaries as % of operating cost	Municipal	0.177	0.098	0.13	0.49
	Private	0.217	0.111		
Wages as % of operating cost	Municipal	0.308	0.119	0.38	0.88
	Private	0.282	0.116		
Fuel as % of operating cost	Municipal	0.245	0.144	0.31	0.41
	Private	0.211	0.124		
Maintenance as % of operating cost	Municipal	0.148	0.144	0.51	0.02
	Private	0.128	0.095		
Depreciation as % of total cost	Municipal	0.402	0.188	0.77	0.42
	Private	0.389	0.162		
INVESTMENT					
Total Investment	Municipal	737,276	1,543,124	0.83	<0.01
	Private	865,075	2,931,407		
Investment per million gals.	Municipal	1,611	1,610	0.69	0.12
	Private	1,803	2,142		
OUTPUT					
Millions of gallons	Municipal	895	1,926	0.96	0.85
	Private	919	1,993		

Table 1 (continued)
INDUSTRY CHARACTERISTICS--SUMMARY STATISTICS

Variable	Ownership	Mean	Standard Deviation	P-Value for t-test of equal means	P-Value for F-test of equal variances
REVENUES					
Gross Revenue	Municipal	55,688	121,310	0.60	<0.01
	Private	87,291	316,392		
Revenue per million gals.	Municipal	96.80	81.20	0.06	0.02
	Private	147.80	125.20		
PROFIT PER MILLION GALLONS AND RATE OF RETURN					
Gross Revenue less Operating Cost (AMONE)	Municipal	29.90	60.80	<0.01	0.04
	Private	86.10	89.00		
Gross Revenue less Total Cost (AMTWO)	Municipal	-14.40	64.00	<0.01	0.01
	Private	44.60	101.20		
Gross Revenue less Total Cost less taxes (AMTHREE)	Municipal	-14.40	64.00	0.03	<0.01
	Private	34.30	103.80		
Rate of Return using AMONE	Municipal	0.022	0.043	<0.01	0.03
	Private	0.063	0.033		
Rate of Return using AMTWO	Municipal	-0.007	0.044	<0.01	0.75
	Private	0.038	0.041		
Rate of Return using AMTHREE	Municipal	-0.007	0.044	<0.01	0.67
	Private	0.031	0.040		

The P-Value for the t-test of equal means given in the Table assumes equal variances. Values assuming unequal variances were virtually identical.

Although there were no statistically significant differences between plants under each type of ownership in the means of the various variables measuring costs, there were differences in the means of variables measuring revenue characteristics. Both mean gross revenues and mean average revenue per million gallons were higher for privately owned utilities than for municipally owned utilities, and in the latter case were statistically significant. Private plants appear to have charged higher prices for water. Comparison of average revenue separately for sales by meter and for sales by contract shows that under both forms of ownership, higher prices were charged on average for meter sales than for contract sales. The difference, however, is much greater for the municipally owned plants. This may have resulted from systematic underpricing of contract sales from the publicly owned utilities.

Differences in revenues were also reflected in differences in profitability. Calculated rate of return, after taxes and depreciation, averaged approximately 3 percent, hardly evidence of monopoly profit.[3] Six of the thirty-two private plants were operating at a loss, and there appears to be no relationship between plant size and rate of return.[4] By contrast, municipally owned plants on average had gross revenues less than total costs and their average rate of return was, consequently, also negative. Nineteen of the thirty-two municipally owned plants were operating at a loss with losses more likely in the smaller plants. Only two of the twelve largest plants reported negative returns, and the average rate of return for those twelve plants was approximately 3 percent--comparable to the return to private plants. Baker's concern that municipally owned waterworks were likely to be subsidized seems well grounded in fact. Publicly owned waterworks charged lower prices, but those prices often did not cover costs, necessitating some form of subsidy.

Although there was little difference in average costs between municipal and private plants, the costs of supplying water are affected by a number of factors which varied considerably across waterworks. In order to better control for these variations when examining the issue of costs and efficiency, we used multiple regression analysis to estimate cubic cost functions.[5] Total cost (both including and excluding estimated depreciation) were specified as a function of the level of output in millions of gallons, type of ownership, and a series of other variables designed to account for differences in conditions of supply. These latter variables included dummy variables for each of several sources of supply: creeks, lakes, rivers, wells, and springs. In addition, a dummy variable was used to differentiate between plants that used steam pumps to distribute water and plants that distributed water solely by gravity. Other variables measured the distance from the water source to the plant, the diameter of the mains, the age of the plant, and the density of consumption measured as the ratio of total output to length of mains.

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[3]This compares with a yield between 3.8 percent and 4.2 percent for American Railroad Bonds in the period 1897-1899 [12, p. A152].

[4]This was confirmed by regressing rate of return as a cubic function of output.

[5]Our procedure is similar to that used by Meyer [13].

The estimated total cost function can be represented as:

$$TC=b_0+b_1Q+b_2Q^2+b_3Q^3+b_4OWN+BX+u,$$

where TC is total operating costs (including and excluding depreciation[6]), Q is output in millions of gallons, OWN is a dummy variable coded 1 for private ownership, X is a vector of other characteristics, and u is a normally distributed error term.

Implicit in our approach are the assumptions that the waterworks were seeking to minimize costs, and that the different waterworks faced the same input prices and technology [10, p. 281]. Since the equation is estimated on cross-sectional data, the cost function represents long-run costs. Our initial OLS estimates revealed that of all the variables in the X vector, only the measure of density was statistically significant, and the other variables were consequently dropped. The results of our estimation are shown as equations 1 and 2 in Table 2.

The coefficients on the ownership dummy, *OWN*, are positive but are not statistically significant. This result remained even when the *DENSITY* variable was omitted. This supports the finding that there was no difference between privately- and publicly owned utilities in the cost of providing service.

An examination of the residuals indicated the possible presence of heteroscedasticity and this was confirmed using Glejser's test [12, p. 262]. Coefficient estimates in the presence of heteroscedasticity remain unbiased and consistent, but are inefficient. Furthermore, the standard errors of the estimates are biased downward, and this means that the actual statistical significance of an estimated coefficient is lower than the reported t-statistic would

[6]Most of the plants provided a figure for estimated depreciation. As the Commissioner noted, ". . .the amounts given as estimated depreciation . . . represent in each case the closest obtainable estimate of the loss in value during the year of each of the plants exclusive of land over and above the expenditures for repairs and renewals, the estimate being based on the best judgment of the official of the plant who furnished the answers to the inquiries submitted by the Department." [16, p. 32]. Because of a likely lack of uniformity in the way the value of depreciation was determined, we estimated cost functions with and without this measure of cost. Taxes and interest expenditures were excluded from the analysis (except that taxes were used when calculating rate of return on capital invested for private plants). Average cost was used in place of total cost in some estimates in an effort to avoid heteroskedasticity.

Table 2
ESTIMATED COST FUNCTIONS--REGRESSION RESULTS

Dependent Variable	Constant	log(Q)	Q	log(Q^2)	Q^2	Q^3 (10^5)	Ownership (Private=1)	Density	R^2
Operating Cost	1591 (0.36)	--	60.7 (5.23)	--	-0.018 (-5.31)	0.018 (6.51)	6961 (1.37)	-892 (-2.64)	0.85
Total Cost	5164 (0.86)	--	70.7 (4.43)	--	-0.17 (-3.67)	0.17 (4.53)	6008 (0.86)	-978 (-2.11)	0.86
Log(Operating Costs per mil. gals.)	6.35 (16.40)	-0.465 (-2.72)	--	0.025 (1.72)	--	--	-0.82 (-0.66)	-0.469 (-4.82)	0.74
Log(Total Costs per mil. gals.)	6.62 (19.30)	-0.304 (-2.01)	--	0.02 (1.55)	--	--	-0.108 (-0.98)	-0.626 (-6.15)	0.76

Note: t-values for estimated coeffcients in parentheses.

otherwise indicate. This only strengthens our finding of no significant differences in the cost of providing water from public and private plants.[7]

Average cost functions were also estimated directly. The logarithmic specification, equations 3 and 4 in Table 2, provided a reasonable fit in terms of R^2 and statistical significance of the estimated coefficients. Once again we found no statistical evidence of a difference between public and private ownership. A quadratic average cost function was also estimated but is not presented because of poor overall fit. Here again the form of ownership was not statistically significant. Thus every specification which we tried produced no evidence of a difference between the cost of providing water from a publicly owned waterworks and the cost from a privately owned waterworks. This conclusion held also when we tested for differences in the components of cost and for the total level of investment. Each component was estimated

[7]We also attempted to correct for heteroscedasticity by using weighted least squares. Neither the statistical significance of any of the estimated coefficients (including ownership) nor the overall explanatory power of the regression changed. The original model was also estimated without the four largest observations which had extremely large variances in errors. Results were similar.

as a cubic function of output using OLS. Form of ownership was statistically insignificant for every component of total cost except salaries, which were significantly higher for private firms. This finding disappeared, however, when the equation was re-estimated using weighted least squares.

SUMMARY

An important aspect of the Progressive movement was the drive for municipal reform and municipal ownership of public utilities. Although the issue of the best form of ownership for American utilities continues to be debated, it was then that the issue first became a public controversy and was a "highly charged ideological issue." [15, p. 213] Both sides in that debate used arguments on the relative economic performance of utilities under each form of ownership. We present an econometric cross-sectional analysis of waterworks in the Progressive era in order to compare their relative economic performance. Our evidence indicates that municipally owned utilities were charging significantly lower prices than privately owned utilities. We have no evidence, however, of any difference in the costs of operation between the two forms of ownership. The lower prices charged by municipally owned waterworks caused them to have lower, even negative, profits and rates of return. Although profits were higher for private plants, their rate of return seems modest in light of investment alternatives then available, suggesting that private utilities were not able to exploit a possible monopoly position.

This finding, although perhaps not very satisfying to those with strong feelings on one side of the issue or the other, is consistent with the results of recent studies, in which no firm conclusions have been reached. It may also be consistent with contemporary studies of the issue. As Harold Platt has stated regarding the issue in Houston, "The inability of Houston officials to solve the dilemma of utility franchises signaled local reformers to look to outside experts for guidance. But the social scientists offered conflicting testimony, because they attempted to solve this complex issue of social policy on the narrow grounds of efficiency. The very failure of economists to demonstrate the superiority of one alternative over the others helped turn the franchise question into such an emotionally charged political issue." [15, p. 135] Modern econometric analysis confirms that "failure" by again showing little effect of ownership on efficiency. We are skeptical, however, that this lack of difference explains the emotion of the time, and do not believe that economists can be faulted for failing to find differences that did not exist.

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