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# CAN UNION LABOR EVER COST LESS?

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## ABSTRACT

This paper examines the effect of unions on efficiency by estimating cost function systems over three different sets of construction projects. The results show that union contractors have greater economies of scale. This gives them a cost advantage in large commercial office buildings, but in school and hospital construction, nonunion contractors have lower costs at all output levels. Despite the cost differences, profits for nonunion contractors in school and hospital construction are no higher than those for union contractors because the burden of higher union costs is shifted to buyers.

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# I. INTRODUCTION

Although a number of studies have found productivity to be higher in unionized establishments and industries, the net effect of unions on efficiency depends on the interaction of the effects of unions on wages and productivity.[1] This paper examines how unions affect three widely accepted measures of efficiency--cost, profit, and price--over three different samples of construction projects.[2] The cost results are obtained with translog cost function systems, an econometric technique which has been applied frequently to labor demand questions but not, surprisingly, to the question of how unions affect efficiency.

The cost function results provide new insights into how union and nonunion firms can compete in the same market. Despite recent declines in percent unionized in construction, the largest projects still tend to be built by union contractors, a phenomenon frequently attributed to threats of violent behavior or political favoritism. In both data sets where economies of scale are present, I find that these economies of scale are more prevalent in the union sample. In a sample of commercial office buildings, higher wages price union contractors out of the market for smaller projects, but greater scale economies enable them to produce larger projects more efficiently than nonunion contractors. However, in a sample of elementary and secondary schools, costs are much higher under unionism at all output levels despite the difference in economies of scale.

Unions do not seem to reduce profits in construction. This happens even in the cases where costs per square foot are higher because these costs are passed on to project owners in the form of higher prices. Geographic market segmentation, which probably results from prevailing wage legislation, keeps union and nonunion profit rates equal despite the price differences in these cases.

## II. METHODOLOGICAL CONCERNS

The relative efficiency of union and nonunion contractors can be estimated with either cost or profit functions. If the demand for structures by owners is exogenous and contractors are cost minimizing price-takers in factor markets, the cost function approach holding factor prices and output constant, is most appropriate. In this framework unions have two types of effects on efficiency: cost function parameters can vary by union status and, for a given set of cost function parameters, higher union wages increase costs at all levels of output.

Alternatively, output could be endogenous either in terms of the number of projects demanded by owners or the magnitude of a given project. In either case a profit function can be used to simultaneously model profits, input demand, and output supply. In this context, unions can influence prices in the product market as well as the production possibilities set and wages. Clark [1984] has argued that the net effect of unions on efficiency is much more difficult to predict in this context, even if unions raise labor productivity and wages by equal amounts. The net effect depends on whether contractors are on or off the labor demand curve and whether labor or management has more bargaining power.

What are the methodological advantages of estimating the dual cost or profit functions rather than the production function? In practice most production function studies have used functional forms which impose restrictions on technology, such as homogeneity, homotheticity, and identical (frequently unitary) elasticities of substitution for all pairs of inputs. These restrictions need not hold and, if production function parameters vary by union status, this could lead to biased estimates of the effect of unions on technical efficiency. By using flexible functional forms for the cost and profit functions, these restrictions can be tested and the sensitivity of the union coefficients to these restrictions can be established.

Of course, such tests could also be done with flexible functional forms for production functions (although only Clark [1980] and Allen [1984] report doing such tests), but this raises a more fundamental question. An OLS production function is appropriate only when input quantities are uncorrelated with omitted variables. When managers choose the quantity of capital, labor and other inputs, this choice must be sensitive to the presence of unions as well as unobserved variables, many of which are likely to be correlated with union status. This classic identification problem vanishes when estimating cost or profit functions in construction. Collective bargaining agreements are usually signed between a local union representing a certain trade or group of trades and an employer association. The agreement sets the price of labor to be hired by any union contractor, but contractors are generally free to hire as much or as little labor as they want on any project.

A convenient aspect of cost and profit functions is that they produce a direct estimate of the net effect of unions on efficiency. If output is not homogeneous with respect to input, this estimate can be allowed to vary with output. In contrast, the effect of unions on efficiency can be estimated only indirectly in the production function approach by comparing union coefficients from production and wage equations. Such comparisons are difficult to make in a statistical sense because these equations always contain different control variables and are usually estimated at different levels of aggregation. Conceptually, such comparisons are difficult to interpret in light of the complexities about efficient contracts and bargaining power noted by Clark [1984].

Despite these attractive features, an important problem remains -- measurement error. The exogenous variables in cost and profit functions are output (in cost functions only), fixed inputs, and factor prices. In cross section data, prices of nonlabor inputs are not generally reported, resulting in an errors in variables problem. Because of the restrictions required to assure homogeneity of degree one of cost with respect to factor prices and symmetry in cross partial effects of factor prices on costs, the direction and magnitude of the bias resulting from this measurement error cannot be predicted. Such bias is also present in production function estimates, especially for capital input, labor quality, and in many cases, the union coefficient but cross- or within-equation restrictions are not involved.

The cost and profit functions also do not provide any guidelines for distinguishing between what Freeman and Medoff [1981] call the price theoretic and the institutional effects of unions. Any union-nonunion difference in parameter estimates will reflect both of these factors. Unless there are perfect controls for capital intensity and labor quality, this will also be true for union coefficients in production functions.

## III. SPECIFICATION

The translog functional form was selected for the cost equation because it imposes relatively few restrictions on the parameters of interest.[3] In the single output case, the function is written

$$\ln C = \alpha_0 + \alpha_Y \ln Y + .5\beta_{YY}(\ln Y)^2 + \sum_i \beta_{Yi} \ln Y \ln P_i + \alpha_F \ln F + .5\beta_{FF}(\ln F)^2$$

$$+ \beta_{YF} \ln Y \ln F + \sum_i \beta_{Fi} \ln F \ln P_i + \sum_i \alpha_i \ln P_i + .5\sum_i \sum_j \beta_{ij} \ln P_i \ln P_j \qquad (1)$$

where C = variable cost, Y = output, F = fixed inputs and $P_i$ = price of variable input i. A three factor specification is used in the results reported below--labor (L), materials (M), and capital (K). Two sets of restrictions from production theory are imposed in all cases: (1) symmetry, which requires that $\beta_{ij} = \beta_{ji}$, and (2) homogeneity of degree one with respect to prices, which requires that

$$\sum_i \alpha_i = 1; \ \sum_i \beta_{Yi} = 0; \ \sum_i \beta_{Fi} = 0; \ \sum_i \beta_{ij} = \sum_j \beta_{ij} = \sum_{ij}\sum \beta_{ij} = 0$$

Shephard's lemma states that $\partial C/\partial P_i = X_i$. In logarithmic terms, this becomes

$$\partial \ln C/\ \partial \ln P_i = P_i X_i/C = S_i,$$

where $S_i$ is the share of factor i in total cost. If the cost function is (1), the share equation for each factor is

$$S_i = \alpha_i + \ \beta_{Yi} \ln Y + \ \beta_{Fi} \ln F + \sum_j \beta_{ij} \ln P_j. \tag{2}$$

To take advantage of the additional information about the parameters appearing in the share equations, (1) and (2) are jointly estimated below using iterated seemingly unrelated regressions. One share equation must be omitted to prevent the variance-covariance matrix of the error terms in (1) and (2) from being singular. Iterated seemingly unrelated regression produces maximum likelihood estimates which are invariant to the choice of which share equation is dropped.

Unions influence construction costs by raising the price of labor and, potentially, changing the cost function parameters. If union work rules or craft jurisdictions make union labor less productive, the entire cost function shifts upward for any given level of $P_i$. The building trades unions also have beneficial effects on productivity, mainly through their effects on training (via apprenticeships), search and screening costs (via hiring halls), and management (via shock effects).[4] All of these factors would shift the cost function downward for any given level of $P_i$.

Christensen and Greene define economies of scale (EOS) as

$$EOS = 1 - \partial \ln C / \partial \ln Y.$$

In (1) this gives us

$$EOS = 1 - \alpha_Y - \beta_{YY} \ln Y - \beta_{YF} \ln F - \sum_i \beta_{Yi} \ln P_i.$$

Union-nonunion differences in EOS can be calculated by estimating $\alpha_Y$, $\beta_{YY}$, $\beta_{YF}$ and $\beta_{Yi}$ separately for union and nonunion projects.

Why might one expect such differences? The most important factor is that unionism can lower the cost of large projects through organizing what would otherwise be a casual labor market. Union hiring halls provide large supplies of skilled labor on relatively short notice, something a single contractor may be unable to find on his own. The union also screens prospective workers, reducing qualitative uncertainty in a market where short term employer-employee relationships predominate. This lowers costs by reducing the amount of managerial and clerical labor needed to recruit and screen workers. It also reduces the cost of turnover and absenteeism, since replacements can be quickly found. If union contractors' recruiting and screening costs increase less rapidly with project size than those of nonunion contractors, this can result in a union cost advantage in larger projects.

In addition union hiring halls reduce uncertainty about the quantity of available labor, which can also result in economies of scale. Without such uncertainty management can plan large projects on a more ambitious, tighter schedule. This reduces the cost of maintaining materials inventories and renting capital equipment. If the project is expected to be completed more rapidly, the anticipated cost of borrowing to meet expenses over the course of the project is also reduced. Since such uncertainty will be present only in large projects, this will result in a further union cost advantage for such projects.[5]

Interview evidence indicates that these economies give union contractors a significant edge over their nonunion competitors. In a survey of nonunion residential contractors in Erie County, N. Y., Foster [1973] found, "In most cases, the inability to recruit sufficient help required some change in the firm's normal operations, such as working overtime and weekends, refusing jobs or running them longer than originally planned, or having the employer do the work himself" [p. 1074]. Bourdon and Levitt [1980] reached even stronger conclusions in their interviews with union and nonunion contractors in eight large SMSAs. They concluded that the major disadvantage to the open-shop sector was "the lack of access to an external labor pool of workers with predictable wages and skills which would enable more firms to bid on larger-scale work" [p. 54].

Another factor which may give union contractors an advantage over nonunion competition in large projects is experience. Until recently the open shop was concentrated in residential and small commercial projects. Managers whose experience was previously confined to projects which could be completed in three months are unlikely to be able to move into projects lasting one or two years and be equally efficient. Such a union cost advantage would only be temporary, but it may very well have been present in the period from which the data come, the early and middle 1970s.

Union work rules are a final factor contributing to union-nonunion differences in economies of scale in construction. Bourdon and Levitt [1980, pp.64-65] have argued that the constraints imposed by union work rules on efficient factor allocation are less likely to be binding on large projects. For instance, ironworkers' contracts usually specify minimum crew sizes. If the contract is enforced on a small job, the result will be overstaffing. On a large project, the provision will be irrelevant. Any union cost disadvantage associated with restrictive work rules should diminish with increasing project size. Of course, this factor alone would not make union costs lower than nonunion costs at any output level.

To test for union-nonunion differences in the cost function parameters the translog system is estimated both over the pooled sample and over the union and nonunion samples separately. The hypothesis that the union and nonunion coefficients are equal is tested by examining the likelihood ratio $\lambda = (\Omega_p/\Omega_s)^{-n/2}$, where $\Omega_p$ = determinant of the disturbance covariance matrix for the pooled specification, $\Omega_S$ = determinant of the covariance matrix obtained from the specification with separate union and nonunion coefficients, and n = the number of buildings in the sample. Test statistics are derived from $-2\ln\lambda$, which is distributed as chi-squared with degrees of freedom equal to the number of restrictions being tested. Results for a specification where only $\alpha_o$ varies by union status are also reported below.

Three other sets of restrictions were examined. The production function corresponding to the cost system is almost homothetic (isoquants for variable inputs have the same slope along a ray from the origin) if $\beta_{Yi} = 0$. An almost homothetic production function is homogeneous (constant elasticity of cost with respect to output) if $\beta_{YY} = 0$. The homogeneity hypothesis is nested within the homotheticity hypothesis, but both are unrelated to the unitary elasticity of substitution hypothesis.

The translog variable profit function is written

$$\ln\pi = \alpha_o + \sum_i \alpha_i \ln P_i + .5\sum_i \sum_j \beta_{ij} \ln P_i \ln P_j \quad (3)$$

$$+ \alpha_F \ln F + .5\beta_{FF} (\ln F)^2 + \sum_i \beta_{Fi} \ln F \ln P_i,$$

where $\pi$ = profits and $P_i$ = prices of variable inputs and output (i = L, M, K, Y).[6] Once again symmetry and homogeneity restrictions are imposed.[7]

Hotelling's lemma states that the partial derivatives of the profit function with respect to input prices are input demand functions. Formally, $\partial\pi/\partial P_i = -X_i$. In logarithmic terms, this becomes

$$\partial \ln\pi/\partial \ln P_i = -P_i X_i/\pi = \alpha_i + \beta_{FI} \ln F + \sum_j \beta_{ij} \ln P_j . \quad (4)$$

Also, the partial derivative of (4) with respect to the price of output is the output supply function. Either the supply equation or one of the three input share equations must be deleted from the system because the dependent variables sum to 1. Maximum likelihood estimates which are invariant to whether the output supply or one of the input demand equations is dropped are obtained by estimating (3) and (4) jointly using iterated seemingly unrelated regressions. The impact of unions on efficiency can be determined by comparing all the parameters in (3) and (4) at different ranges of $P_i$ or by allowing $\alpha_0$ to vary by union status.

A key assumption behind the profit function approach is that output prices are determined competitively. As I will explain more fully below, the results for cost, profit, and price for the school and hospital samples do not seem to be consistent with this assumption, making the results uninterpretable in terms of technical efficiency. Application of the profit function approach to the question of how unions affect technical efficiency must await the arrival of a more appropriate data set.

## IV. DATA

Three samples of buildings are examined: 83 commercial office buildings (64 union, 19 nonunion), 68 elementary and secondary school buildings (57 union, 11 nonunion), and 44 hospitals and nursing homes (36 union, 8 nonunion). The characteristics of these data sets are discussed in Allen [1986a, b].

Different information on capital expenditures was provided in the surveys. In the school survey, each contractor for each project was asked to provide the rental cost, the allowance by the contractor for owned equipment, or the equivalent of rental cost for each type of equipment. In addition, the number of hours operated is also reported for each. The sum of all capital equipment expenditures for all contractors on a particular project is used here as the capital cost measure for schools. The price of capital is obtained by dividing this figure by capital hours. In the office building and hospital surveys each contractor provided equipment expenditure information (depreciation or rental cost), as well as the interest expenses. The sum of these expenses for all contractors for a particular office building is the capital cost measure for this sample. Offsite capital (e.g., structures, office furniture and equipment) is not reported for either sample.

Since capital hours are not reported for the office building sample, a capital price variable had to be constructed from other data sources. The variable used below is the rate of return estimated from the 1972 Census of Construction Industries for the Census division in which each project was located. Values of this variable for smaller geographic units could not be constructed because individual states or SMSAs are not identified in the data to protect the confidentiality of contractors and subcontractors. This introduces some measurement error bias into the analysis, the magnitude of which will be assessed below.

Earnings and hours are reported for all onsite work. Almost all of this represents production labor. The only nonproduction categories reported are clerical workers (e.g., timekeepers), professional and technical workers (e.g., draftsmen, engineers), and foremen. Issues concerning the separability of labor into smaller aggregates are ignored here.

Fringe benefit costs are not reported. Since these costs are much larger in the union sector, labor costs are underreported by a much greater extent for union than nonunion contractors.[8] To correct for this, I add estimated fringe benefits to labor costs for union contractors only. This increases the likelihood that the results will show higher costs in the union sector. Fringe benefits are paid on an hourly basis in union construction. I assume that fringe benefits equal 14.6 percent of earnings, a figure derived from 1972 national averages of wages and benefit costs in union contracts for all occupations in 68 cities.[9] The price of labor equals earnings plus estimated fringes divided by hours.

The price of materials variable is derived from the 1973 Dodge Manual for Building Construction Pricing and Scheduling. The Dodge Manual reports a materials price index for 80 cities. These were aggregated into nine indices for each of the Census divisions, using 1972 construction employment in each city as weights. Since this index varies much more across rather than within regions, this aggregation is unlikely to seriously contaminate the results.

Square footage is used as the output measure in both samples. Differences in building characteristics such as type of frame or height are ignored. In previous work examining production functions over these samples in Allen [1986a, b], these variables had relatively little effect on estimates of the union-nonunion productivity difference. Other output measures are available for the school sample (student capacity and classrooms) and for the hospital sample (beds), but these are highly correlated with square footage.[10]

Fixed inputs are not reported in any of the three surveys. Assuming that offsite labor and capital vary directly with the size of the general contractor, this variable seems to be a reasonable proxy. In the office building sample the 1974 dollar volume of business in private office building construction for the general contractor is reported along with the share of private office building construction in his 1974 total dollar volume. The ratio of these two variables equals 1972 total dollar volume and is used in the cost function model as a proxy for fixed inputs for that sample.[11] The school sample reports classrooms built by the general contractor in 1972 and the share of 1972 dollar volume in school construction in 1972 total dollar volume. The number of classrooms is used in the cost function model as a proxy for fixed offsite inputs in the school sample. No similar proxies for fixed inputs are available for the hospital and nursing homes sample. The effects of omitting this variable will be assessed on the other two data sets.

## V. COST FUNCTION RESULTS

The mean cost per square foot by union status and building size for office building, school, and hospital construction is reported in Table 1. The size categories are defined so that each sample of buildings is divided into three groups which have almost the same number of observations. Nonunion observations are concentrated in the smallest group in each sample.

Across buildings of all size categories, cost per square foot is 4 percent lower in office building construction when union labor is used. Union-nonunion differences in cost per square foot vary with building size. Cost per square foot is 4 percent higher in the union sector for buildings in the smallest size category. In both sectors cost per square foot is lower in the middle size category, but the decrease in average costs is much greater for the nonunion sector. As a result, union labor is considerably more costly (44 percent) in buildings in the middle size category. When building size increases above 75,000 square feet, average cost rises for both union and nonunion labor. The cost increase is much greater for nonunion labor, resulting in a cost advantage for the union sector. Average costs are 23 percent lower for the union buildings in this size category.

Costs in the nonunion sector are cheaper than costs in the union sector in each of the size categories of school and hospital construction. Overall, costs are 48 percent higher for schools and 36 percent higher for hospitals built with union crews. In the school sample, the difference is widest (52 percent) in the small and middle size categories and is smallest (37 percent) for schools in the largest size category. A similar pattern is present in the hospital sample, as the difference narrows from 63 percent in the smallest size category to 27 and 19 percent in the middle and largest size categories. Even though union costs are always greater, the narrowing of union-nonunion cost differences with increasing building size is consistent with the pattern observed for office buildings.

Two cost function specifications were examined, one where the intercept of the cost function varies by union status and the other where all coefficients vary by union status. In the hospital sample, homotheticity and homogeneity with respect to output could not be rejected, so these restrictions were imposed. No restrictions are imposed on the other two samples. The union coefficients (S.E.) are reported below:

| | |
|---|---|
| Commercial Office Buildings | .200<br>(.105) |
| Elementary and Secondary Schools | .161<br>(.079) |

| | |
|---|---|
| Hospitals and Nursing Homes | .113 (.146) |

These coefficients show costs are lower for union contractors in office building construction, but in school and hospital construction union contractors have higher costs, holding input prices and output constant. The hypothesis that the union intercept is identical to the nonunion intercept is rejected at the 95 percent confidence level for the school sample and the 94 percent confidence level for the office building sample.

To implement the second approach, the hypothesis that the union and nonunion coefficients in (1) and (2) are equal must be tested. Because there are only 8 nonunion observations in the hospital sample, this approach is not applied to that data set as there are only 10 degrees of freedom in the least restrictive specification. The results for nonunion schools in the least restrictive specifications should also be viewed with caution, as there are as few as 18 degrees of freedom for that sample.

Table 2 reports the results of likelihood ratio tests of the hypothesis of equal union and nonunion coefficients for both samples under a variety of restrictions, along with tests of the homotheticity, homogeneity, and unitary elasticity of substitution restrictions within the union and nonunion samples. Complete results for the least restrictive specification are reported in the appendix. In the school sample, the hypothesis of equal union and nonunion coefficients can be rejected at the 95 or 99 percent confidence level in all specifications. Union-nonunion differences in the parameter estimates are less pronounced in the office building sample, except when the restriction $\beta_{ij} = 0$ is imposed. The main reason for this is the relatively minor union-nonunion difference in the $\beta_{ij}$ estimates. The hypothesis that $\beta_{ij} = 0$ in the union equation cannot be rejected. Once this restriction is imposed, the union and nonunion coefficients become much more distinct from each other. However, when the homogeneity restriction is reimposed, the distinction comes close to vanishing again. Thus, the key difference between the union and nonunion coefficients in the office building sample is the relationship of cost to output.[12]

Assumptions have to be made about factor prices, output levels, and fixed inputs before making any comparisons of economies of scale or costs. As there was no correlation between factor prices and building size in any of the samples, the mean factor prices for union projects are inserted in the union equations and the mean factor prices for nonunion projects in the nonunion equations. Different sets of means are used for office buildings and schools. This assumption places the union projects at an immediate cost disadvantage because of higher union wages.

Focusing on a single output level in each sample is potentially misleading, given the wide range of building sizes in all of the samples. Because homogeneity of degree one of the cost function with respect to output is easily rejected for all samples except nonunion schools, it is quite possible that union labor may be cost effective in some output ranges but not in others. Rather than focusing on a single summary statistic, cost functions and economies of scale functions are reported in Table 3 and Figures 1 and 2. The ranges of output levels where the cost of union (nonunion) projects is less than that of nonunion (union) projects, and where economies of scale prevail are also reported. The mean value of fixed inputs for union buildings in each sample is used in both the union and nonunion equations for that sample. Because of the possibility of errors in measuring fixed inputs, two sets of estimates are reported: one where the fixed input variable is included in the model and another where all fixed input coefficients are restricted to zero.

A. Economies of Scale. The most noticeable difference in the parameter estimates between the union and nonunion buildings is the rate at which costs change at different output levels. In nonunion construction diseconomies of scale first appear at lower output levels and increase more rapidly with output than in the union sector. Diseconomies of scale first appear in nonunion office buildings at 26 to 28 thousand square feet of space. They disappear in nonunion schools at 41,606 square feet in the model including fixed inputs and at 80,178 square feet in the model without fixed inputs. Economies of scale are present in union office building construction over a much larger range of output levels than in nonunion office building construction--through 67 to 69 thousand square feet. More importantly, the rate at which costs rise with output is much lower in the union sector. The second derivatives (in logs) of cost with respect to output are about four times larger for nonunion office buildings than union office buildings. The pattern of economies of scale over various output levels in union school construction is the reverse of that in the other three samples. Diseconomies of scale are present until school size reaches 78 to 86 thousand square feet in the union sector. Economies of scale are present at all higher output levels.

The evidence that costs increase much more rapidly with building size in the nonunion sector is consistent with the theory and anecdotal evidence cited in Section III regarding the disadvantages nonunion contractors face in large projects. The exact source of these economies cannot be isolated, but evidence on the ratio of overtime to total hours suggests union hiring halls are a contributing factor. Working overtime is the usual managerial response in the short run to situations where labor supply is inadequate. If hiring halls contribute to economies of scale, there would be less overtime in union projects, with the difference widening with project size. To examine this possibility each sample is split into groups of buildings above and below 50,000 square feet in size. Union buildings in the office building sample which are larger than the largest nonunion building (225,000 sq. ft.) are reported separately. The percentages (S.D.) of overtime hours are:

| | Commercial office buildings | | Elementary and secondary schools | |
|---|---|---|---|---|
| | Union | Nonunion | Union | Nonunion |
| Less than 50,000 sq. ft. | .40<br>(.92) | .36<br>(.83) | .37<br>(.68) | .54<br>(.59) |
| More than 50,000 sq. ft. | .56<br>(.68) | 2.61<br>(1.96) | 1.09<br>(1.72) | 1.90<br>(2.64) |
| More than 225,000 sq. ft. | 1.84<br>(1.43) | - | - | - |

In both samples there is little difference in overtime ratios between union and nonunion contractors for smaller buildings. Overtime ratios increase substantially among the larger buildings, especially for nonunion contractors. They used 75 percent more overtime in larger schools and 366 percent more overtime in larger office buildings. There is also much greater variance in overtime among the nonunion subcontractors in the larger buildings. Although these overtime differences in larger buildings can account for no more than a 1 percent cost difference in these samples, these results are consistent with the effectiveness of hiring halls.

B. <u>Cost Comparisons</u>. In office building construction, costs are lower when union labor is used in buildings with more than 72 to 74 thousand square feet of space. The gap in costs widens considerably with increasing building size because of the greater economies of scale under unionism. The cost function coefficients also imply that union contractors have a comparative advantage in producing projects with less than 6,000 square feet, but the magnitude of these estimated differences is quite small.

Are these results attributable to unionism or to the greater average size of buildings in the union sample? The largest nonunion office building in the sample has 225,000 square feet of space. There are 16 union buildings in the sample with more square footage. If the cost function for the smaller union buildings is quite different from that for the largest ones, it is possible that these union-nonunion cost comparisons are misleading. To test this the cost system was re-estimated over all union buildings with 200,000 square feet or less of space. The key results were basically unchanged. Construction costs are lower under unionism in this restricted sample in all buildings with more than 77,964 square feet of space.

Although these cost differences are economically significant, the small size of the sample raises the question of their statistical significance. Let $C_i$ represent costs for union (i=u) and nonunion (i=n) projects. The standard error of $\ln C_u - \ln C_n$ can be estimated under the assumption that $\text{cov}(\ln C_u, \ln C_n) = 0$ and used to construct a 95 percent confidence interval of the range of output where $\ln C_u = \ln C_n$. In the specification where fixed inputs were included, the hypothesis of no cost difference could be rejected for all office buildings with more than 167,042 square feet. In the specification where fixed inputs are excluded, it could be rejected for all office buildings with more than 153,430 square feet. While this range is considerably smaller than that reported in Table 2, the key result of greater union efficiency in larger buildings still holds. It should also be noted that the range where $\ln C_u > \ln C_n$ at the 95 percent confidence level is more limited as well: below 31,382 square feet when fixed inputs are included and below 35,490 when fixed inputs are excluded.

School construction costs are much higher in the union sector. In the specification where fixed inputs are included, union contractors are less efficient except for schools with more than 197,008 square feet. When the fixed input coefficients are restricted to zero, union costs are greater than nonunion costs in buildings with up to 293,021 square feet, which is larger than the largest building in the nonunion sample. Further, once standard errors of $\ln C_u - \ln C_n$ are estimated, the hypothesis that $\ln C_u < \ln C_n$ can be rejected throughout the range of the nonunion sample whether fixed inputs are included in the model or not.

All but one of the 11 nonunion schools in the sample were built in the South, which could make the above comparisons misleading. The above results could actually reflect North-South differences in construction costs rather than union-nonunion differences. To test this possibility, the translog cost system was re-estimated for the union and nonunion samples over Southern schools only. The results showed union costs to be above nonunion costs in Southern schools at all output levels.[13]

To assess the bias resulting from measurement error in the capital price variable in the office building sample, the ratio of equipment costs to equipment hours was replaced in the cost function model for the school sample by the rate of return variable used as the capital price proxy for office buildings. This had no effect on the main cost function results--school construction costs remained higher at all levels of output for union contractors. Thus it does not seem likely that the results for office buildings have been seriously biased by measurement error in the capital price variable.

## VI. PROFITS AND PRICES

The greater costs of union contractors in the school and hospital samples must be absorbed by the contractors in the form of lower profits, passed on to the buyer in the form of higher prices, or both. This section analyzes evidence on profits and prices to determine who pays for the higher cost of union labor in these two samples.

Profit in each sample is defined as the difference between the value of the general contract for the entire building and the sum of the costs of labor, materials, and capital. The ratio of profit to the value of the contract is a useful summary measure for making comparisons across union and nonunion buildings within a sample and across different types of construction. Although the rate of return on equity is a more desirable measure, this must be calculated over a given period of time encompassing a number of projects; it cannot be calculated from data pertaining to a single project. These ratios are reported below by union status for each of three samples:

| | Union mean | Nonunion mean |
|---|---|---|
| Commercial office buildings | 21.6 | 21.8 |
| Elementary and secondary schools | 20.2 | 20.3 |
| Hospitals and nursing homes | 24.8 | 23.4 |

In all three samples, the mean ratio of profits to the value of the contract is almost identical for union and nonunion contractors. This is a very striking piece of evidence, especially in light of the fact that estimated fringe benefits are not included in the labor costs of nonunion contractors. This assumption biases the profits of nonunion contractors upward. When estimated fringe benefits are omitted from the labor costs of union contractors, the union profit rate increases by four percentage points. Under this assumption a t-test of the means finds them significantly different from each other at the 11 percent confidence level for office buildings and hospitals and at the 4 percent confidence level for schools. This suggests the ratio of profits to contract amount for union contractors is slightly higher than that for nonunion contractors.

How can profits for union contractors in school and hospital construction be greater than or equal to those of nonunion contractors in light of the higher costs per square foot? The answer is fairly obvious--the price per square foot is higher in the projects built by union contractors in those two samples. The following union coefficients were obtained from hedonic price equations estimated over each of the three samples:[14]

| Sample | Union coefficient (S.E.) |
| --- | --- |
| Commercial office buildings | .004 (.099) |
| Elementary and secondary schools | .178 (.081) |
| Hospitals and nursing homes | .078 (.112) |

Holding square footage and other building characteristics constant, the contract amount is 19 percent higher in schools and 8 percent higher in hospitals built by union contractors. Although the coefficient for hospitals is not estimated very precisely, it certainly reconciles the difference between the effects of unions on costs and on mean profit rates for that sample.

This naturally leads to another question--how can union contractors receive a higher price for the same school or hospital project than nonunion contractors? The answer seems to be geographic market segmentation created by prevailing wage laws. The union contractors in the school and hospital samples seem to face no nonunion competition; the nonunion contractors, no union competition. All of the nonunion schools and hospitals are built in the South Atlantic, East South Central, West South Central, and West North Central divisions where percent union tends to be very low. Even though union projects were present in all nine divisions in both samples, of the six states in which nonunion schools are located, only one state contained any union schools. None of the nonunion hospitals were located in states which had any union hospitals in the sample.

No such market segmentation is present in the office building sample. Nonunion office buildings are located in six of the nine Census divisions, the exceptions being the West North Central, East South Central, and the Pacific divisions. Union projects were observed in all nine divisions. Out of the 11 states in which nonunion office buildings were observed, seven also contained union office buildings.

A plausible explanation for the presence of market segmentation in the school and hospital samples and its absence in the office building sample is prevailing wage legislation. Minimum wages for most of the school sample and all of the hospital sample are determined by the Davis-Bacon Act or state prevailing wage laws. As a general rule these minimum wages are well above the federal minimum wage and in many cases equal (but never exceed) the union wage.[15] This constraint binds nonunion contractors only and thereby reduces their ability to compete for projects in the public sector. Since these laws have no direct effect on private sector work, there is no reason to expect such segmentation in the office building sample.

## VII. CONCLUSION

The results of this paper support a "competitive union" model of trade union behavior in the office building sample and a "monopoly union" model in the school and hospital samples. Since the same unions appear in all three samples, the remaining issue is to account for this pattern of union behavior. This boils down to two questions: why do union contractors in school and hospital construction have greater costs and how is entry by nonunion contractors prevented in these cases?

A plausible explanation for the greater costs of union contractors in school and public hospital construction is that government officials have little incentive to produce buildings at lower than budgeted cost. The frequent use of one shot sealed bid auctions to let contracts exacerbates matters by facilitating collusive arrangements.[16] Private hospital owners may also lack such incentives since they receive most of their revenue from governments and insurance companies rather than the individuals who use their services. In contrast commercial office building owners can threaten to delay, cancel, or relocate a project. They can also negotiate with individual bidders for cost reductions since they are not forced to award contracts to the lowest bidder in a one shot sealed bid auction. The net result is that contractors and unions stand to collect rents in school and hospital construction, but not in commercial office building construction.

Nonunion contractors should appropriate any rents for themselves by producing at minimum cost. Unions may instead choose to distribute rents in the form of increased on-the-job leisure or job opportunities. Although this is not the most efficient method of rent sharing, other approaches (higher wages, side payments) would signal the presence of rents to outsiders and thus may not be a stable solution. Political factors within the union may also dictate such a solution, since the least skilled union members may already be priced out of private sector work. This explanation can account for the greater cost of union contractors in school and hospital construction. Profits are equalized by competition within the union and nonunion sectors and by the threat of entry into either sector.

Why don't nonunion contractors go after this business? Even at union wage rates they might be able to produce these projects at lower cost if union contractors are hiring excess amounts of labor. One possible answer is that unions take this threat into account when deciding how much excess labor should be hired. If (1) the prevailing wage laws constrain nonunion contractors from producing at minimum cost and (2) they are less efficient when forced to pay union wages than union contractors would have been if they produced at minimum cost, unions have a wedge which can be used to pad the payrolls while simultaneously preventing the entry of nonunion competition. As long as markets remain segmented, union contractors can maintain profit rates by passing the higher costs to project owners in the form of higher prices. Another possibility is that nonunion contractors are reluctant for personnel reasons to bid on projects where they would have to overpay their workers. Worker morale could deteriorate if employees receive different wage rates for identical types of work, resulting in a decline in overall profitability.

This paper has two major implications. First, in the case of large commercial office buildings, union contractors can compete effectively with nonunion contractors because of greater economies of scale. Second, reduced efficiency results when the building trades unions operate in an environment where managers lack incentives to minimize costs. Although further work is clearly necessary, these findings point to a more general model where the behavior of unions fits the framework of the "competitive union" model when product markets are competitive while the "monopoly union" model best describes union behavior in other settings.

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NOTES

1. Studies examining the effect of unions on productivity are summarized in Freeman and Medoff (1984) which reports complete references.

2. The only previous study to examine the effect of unions on cost is Salkever (1982), who found operating expenses per inpatient day were 6 percent higher in unionized hospitals. The effect of unions on profits has been examined in Freeman (1983), Ruback and Zimmerman (1984), Clark (1984), and Salinger (1984). All of these studies find unionism to be associated with lower profits.

3. The discussion below follows closely that in Christensen and Greene (1976).

4. These arguments and supporting references are found in Allen (1984 and 1986b).

5. The possibility of strikes means that unions can also increase uncertainty about the quantity of available labor. Strikes arise in the building trades not only as a result of failure to agree to a new contract, but also as a consequence of jurisdictional disputes among different unions. This type of uncertainty is present in all projects, regardless of size, so it should shift only the intercept of the cost function and have no effect on the relationship between cost and output.

6. The properties of the profit function are more fully discussed in Diewert (1974) and Lau (1978). For empirical applications see Yotopoulos and Lau (1973), Trosper (1978), Sidhu and Baanante (1981), and Antle (1984).

7. If the actual magnitude of fixed inputs equals the desired magnitude, the regularity conditions for a variable profit function require profits to be homogeneous of degree one with respect to fixed inputs, implying $\alpha_F = 1$ and $\beta_{FF} = 0$.

8. Evidence showing that the effect of unions on fringe benefit expenditures is larger (in percentage terms) than the effect of unions on wages is reported in Freeman (1981).

9. This figure was obtained from U. S. Department of Labor (1974).

10. Simple correlation coefficients for each pair of these output measures in the school sample are:

| | |
|---|---|
| Square footage-student capacity | .874 |
| Square footage-total classrooms | .887 |
| Student capacity-total classrooms | .937 |

In the hospital sample the correlation coefficient between beds and square footage is .691. All correlation coefficients are significant at the .0001 level.

11. The general contractor did not report 1974 dollar volume of office building construction in five cases. Imputed values in these cases were obtained from regressions estimated over the other 78 projects in the sample. Details are available upon request.

12. To test whether $\alpha_Y$ and $\beta_{YY}$ differed significantly from each other by union status, union interaction terms for these two parameters were estimated along with a union intercept term. No restrictions were imposed on homogeneity, homotheticity, or demand elasticities. The coefficients (S.E.) of the parameters which were allowed to vary by union status are as follows:

| | | | | | |
|---|---|---|---|---|---|
| $\alpha_o$ | 18.446<br>(5.857) | $\alpha_Y$ | -2.090<br>(1.180) | $\beta_{YY}$ | .405<br>(.120) |
| Union | -11.873<br>(6.179) | $\alpha_Y$ *Union | 2.429<br>(1.217) | $\beta_{YY}$ *Union | -.250<br>(.119) |

Each of the union interaction coefficients is significantly different from zero at a 6 percent or lower confidence level.

13. The cost functions at the respective sample means obtained over observations in the South in a specification with the fixed input coefficients restricted to zero but without any restrictions on homogeneity, homotheticity, or demand elasticities are as follows:

| <u>Sample</u> | <u>Cost Function</u> |
|---|---|
| Union | $\ln C = .251(\ln Y)^2 - 4.677 \ln Y + 34.755$ |
| Nonunion | $\ln C = .096(\ln Y)^2 - 1.202 \ln Y + 15.110$ |

Union costs were greater than nonunion costs at all output levels.

14. The hedonic price equation specifications are reported in more detail in Allen (1985).

15. Allen (1983) discusses how the Labor Department sets prevailing wages under the Davis-Bacon Act and estimates how they affect federal construction costs. The paper shows that there is no longer an automatic tendency in the Labor Department to set prevailing wages at union scale, except in nonresidential building construction. Since both schools and hospitals fall into this category, however, it seems reasonable to conclude that Davis-Bacon has contributed to the geographic market segmentation observed in these two samples without contradicting the main result of this other paper.

16. Stigler (1983, Ch. 5) has argued that this approach increases the chances that a price-fixing arrangement will be successful because parties cannot secretly underbid their co-conspirators. The recent spate of bid-rigging convictions in highway construction suggests this model has some explanatory power.

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Table 1. Cost per square foot in office building, school, and hospital construction, by building size and union status

| Sample | Union | Nonunion | Union ÷ nonunion |
|---|---|---|---|
| Office Buildings | | | |
| Entire sample | 19.7 | 20.5 | 0.96 |
| | (7.8) | (8.0) | |
| 16,000 sq. ft. or less | 21.6 | 20.8 | 1.04 |
| | (6.7) | (8.0) | |
| 16,001-75,000 sq. ft. | 17.9 | 12.5 | 1.43 |
| | (7.0) | (1.1) | |
| More than 75,000 sq. ft. | 20.5 | 26.7 | 0.77 |
| | (8.9) | (5.3) | |
| Elementary and Secondary Schools | | | |
| Entire sample | 20.2 | 13.6 | 1.48*** |
| | (5.1) | (2.8) | |
| 50,000 sq. ft. or less | 19.3 | 12.7 | 1.52*** |
| | (4.7) | (1.8) | |
| 50,001-100,000 sq. ft. | 21.2 | 13.9 | 1.52*** |
| | (5.3) | (3.8) | |
| More than 100,000 sq. ft. | 20.1 | 14.7 | 1.37 |
| | (5.2) | (1.7) | |
| Hospitals and Nursing Homes | | | |
| Entire sample | 42.7 | 31.4 | 1.36** |
| | (14.0) | (9.7) | |
| 60,000 sq. ft. or less | 46.9 | 28.7 | 1.63** |
| | (17.2) | (5.9) | |
| 60,001-200,000 sq. ft. | 44.6 | 35.1 | 1.27 |
| | (9.9) | (15.5) | |
| More than 200,000 sq. ft. | 36.7 | 30.9 | 1.19 |
| | (12.8) | (N/A) | |

Note: Standard deviations are reported in parentheses.
*Significant at 10 percent confidence levels using two-tailed t-test
**Significant at 5 percent confidence levels using two-tailed t-test
***Significant at 1 percent confidence levels using two-tailed t-test

Table 2. Log likelihood ratio tests of cost function restrictions by union status and of equality of union and non coefficients for office building and school construction

| | Tests of cost function restrictions | | | | | Tests of equality of union and nonunion coefficients under various restrictions | | |
|---|---|---|---|---|---|---|---|---|
| | | Commercial office buildings | | Elementary and secondary schools | | | | |
| Restrictions | Degrees of freedom | Union | Nonunion | Union | Nonunion | Degrees of freedom | Commercial office buildings | Elementary secondary |
| None | - | - | - | - | - | 15 | 22.12 | 36.12*** |
| Homotheticity | 2 | 6.16** | 5.32* | 12.26*** | 4.38 | 13 | 21.40* | 25.77** |
| Homotheticity and homogeneity | 3 | 15.57*** | 20.56*** | 14.50*** | 5.73 | 12 | 12.40 | 25.83** |
| Unitary $\sigma$ | 3 | 4.02 | 11.89*** | 23.92*** | 1.44 | 12 | 33.83*** | 47.48*** |
| Unitary $\sigma$ and homotheticity | 5 | 10.92** | 23.29*** | 33.20*** | 5.82 | 10 | 24.50*** | 37.55*** |
| Unitary $\sigma$, homotheticity, and homogeneity | 6 | 22.05*** | 38.80*** | 35.18*** | 10.43 | 9 | 16.47* | 34.57*** |

Note: The figures reported here are $-2\ln\lambda$, which is distributed $X^2$.

* = rejected at 90% confidence level.
** = rejected at 95% confidence level.
*** = rejected at 99% confidence level.

Table 3. Costs and economies of scale for office building and school construction, by union status

| | Commercial office buildings | | Elementary and secondary schools | |
|---|---|---|---|---|
| | Union | Nonunion | Union | Nonunion |
| Range of output in sample (sq. ft.) | 3650-1700000 | 3000-225000 | 21000-364000 | 19531-280000 |
| Model including fixed inputs | | | | |
| 1. lnC | $.078(\ln Y)^2-.739\ln Y+12.448$ | $.281(\ln Y)^2-4.748\ln Y+31.890$ | $-.083(\ln Y)^2+2/871\ln Y-7.505$ | $.284(\ln Y)^2-5.052+34.541$ |
| 2. EOS | $1.739-.156\ln Y$ | $5.748-.562\ln Y$ | $-1.871+.166\ln Y$ | $6.052-.569\ln Y$ |
| 3. Range of output where cost is lower | $Y < 5213; Y > 72403$ | $5213 < Y < 72403$ | $Y > 197008$ | $Y < 197008$ |
| 4. Range of output where EOS > 0 | $Y < 69335$ | $Y < 27667$ | $Y > 78511$ | $Y < 41606$ |
| Model excluding fixed inputs | | | | |
| 1. lnC | $.040(\ln Y)^2+.111\ln Y+7.748$ | $.186(\ln Y)^2-2.792\ln Y+21.943$ | $-.091(\ln Y)^2+3.056\ln Y-8.626$ | $.170(\ln Y)^2-2.828\ln Y+24.084$ |
| 2. EOS | $.889-.080\ln Y$ | $3.792-.373\ln Y$ | $-2.056+.181\ln Y$ | $3.828-.339\ln Y$ |
| 3. Range of output where cost is lower | $Y < 5855; Y > 73792$ | $5855 < Y < 73792$ | $Y < 21078; Y > 293021$ | $21078 < Y < 293021$ |
| 4. Range of output where EOS > 0 | $Y < 66970$ | $Y < 26004$ | $Y > 85734$ | $Y < 80178$ |

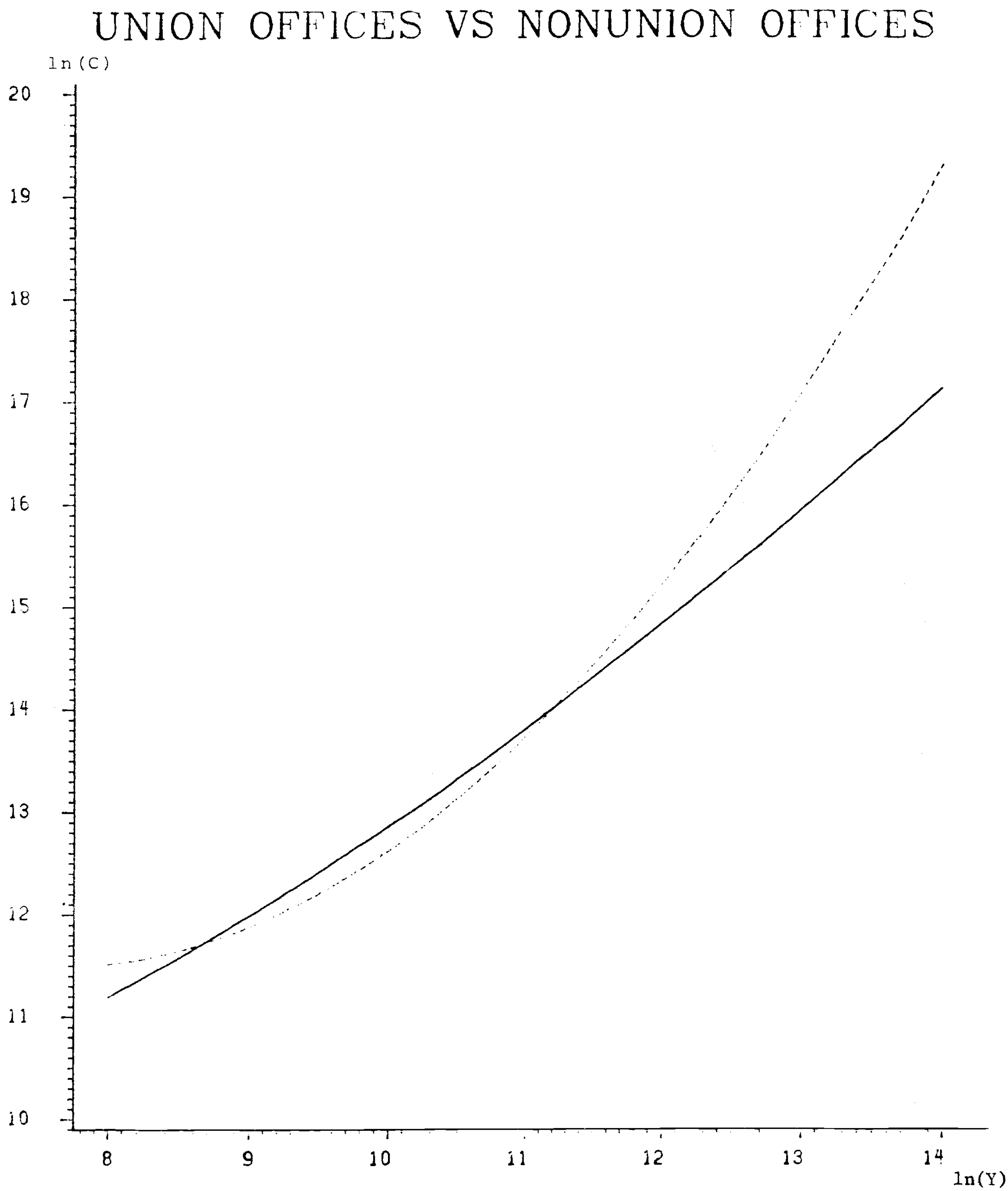


Figure 1. Cost functions for union and nonunion commercial office buildings.

LEGEND SOLID LINE=UNION BROKEN LINE=NONUNION

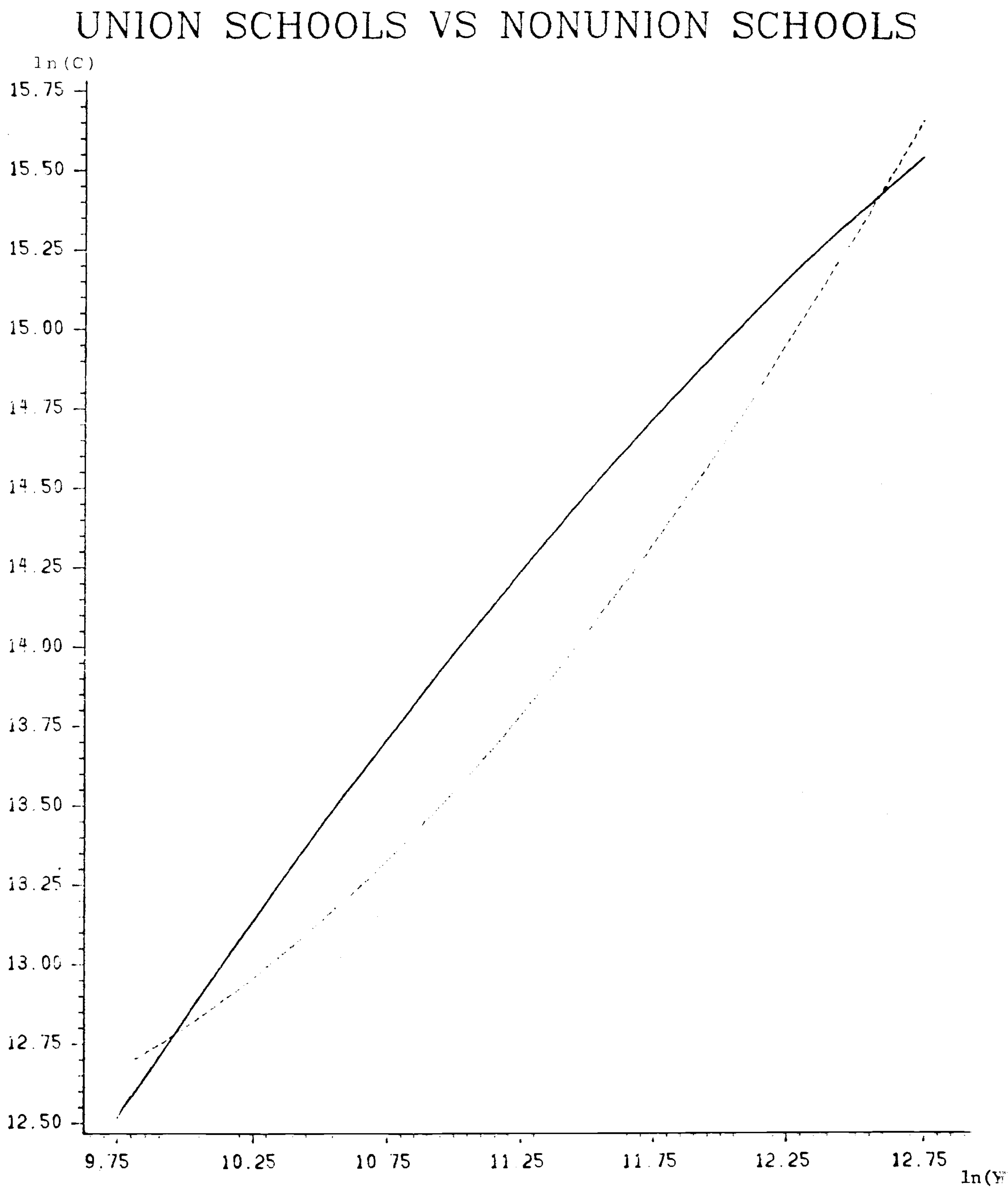


Figure 2. Cost functions for union and nonunion elementary and secondary schools

LEGEND: SOLID LINE=UNION BROKEN LINE=NONUNION

APPENDIX

Table A. Translog cost system estimates with fixed inputs

| | Commercial office buildings | | | Elementary and secondary schools | | |
|---|---|---|---|---|---|---|
| | Pooled | Union | Nonunion | Pooled | Union | Nonunion |
| Parameter estimates: | | | | | | |
| $\alpha_o$ | 7.378 | 6.610 | 13.382 | -3.667 | -8.371 | 19.981 |
| | (2.244) | (2.945) | (6.264) | (6.334) | (6.825) | (44.913) |
| $\alpha_Y$ | .192 | .341 | -2.198 | 1.995 | 2.847 | -2.958 |
| | (.365) | (.423) | (1.234) | (1.192) | (1.271) | (10.498) |
| $\beta_{YY}$ | .156 | .156 | .562 | -.087 | -.166 | .568 |
| | (.047) | (.053) | (.176) | (.114) | (.120) | (1.304) |
| $\alpha_M$ | .922 | .883 | .481 | 1.089 | 1.209 | .646 |
| | (.092) | (.200) | (.199) | (.090) | (.118) | (.465) |
| $\alpha_K$ | -.060 | -.155 | .066 | .0002 | .0002 | -.005 |
| | (.056) | (.106) | (.066) | (.026) | (.026) | (.132) |
| $\beta_{MM}$ | .142 | .097 | .217 | .141 | .174 | .138 |
| | (.048) | (.092) | (.076) | (.023) | (.042) | (.150) |
| $\beta_{MK}$ | .012 | .013 | -.087 | .004 | -.0002 | .028 |
| | (.030) | (.041) | (.034) | (.005) | (.007) | (.027) |
| $\beta_{KK}$ | -.021 | -.044 | .072 | .005 | .005 | -.001 |
| | (.026) | (.032) | (.030) | (.002) | (.002) | (.011) |
| $\beta_{YM}$ | .011 | .007 | .034 | -.023 | -.028 | .016 |
| | (.007) | (.009) | (.020) | (.008) | (.008) | (.045) |
| $\beta_{YK}$ | .006 | .008 | .002 | -.005 | .003 | .015 |
| | (.003) | (.004) | (.006) | (.002) | (.002) | (.013) |
| $\alpha_F$ | -.090 | -.145 | .689 | .272 | .349 | 1.623 |
| | (.287) | (.352) | (.775) | (.549) | (.544) | (8.474) |
| $\beta_{FF}$ | .044 | .054 | .052 | -.046 | -.054 | .875 |
| | (.029) | (.032) | (.100) | (.088) | (.088) | (1.327) |
| $\beta_{FM}$ | -.009 | -.009 | -.007 | .007 | .009 | .012 |
| | (.006) | (.007) | (.010) | (.007) | (.008) | (.059) |
| $\beta_{FK}$ | -.001 | -.002 | .003 | -.004 | -.002 | -.023 |
| | (.002) | (.003) | (.003) | (.002) | (.002) | (.015) |

Table A (continued)

| | Commercial office buildings Pooled | Union | Nonunion | Elementary and secondary schools Pooled | Union | Nonunion |
|---|---|---|---|---|---|---|
| $\beta_{FY}$ | -.056 | -.065 | -.156 | -.007 | -.008 | -.506 |
| | (.029) | (.031) | (.117) | (.060) | (.059) | (1.069) |
| Mean factor shares: | | | | | | |
| Materials | .572 | .559 | .611 | .582 | .571 | .645 |
| Capital | .040 | .041 | .034 | .026 | .026 | .026 |
| Labor | .388 | .400 | .355 | .392 | .404 | .329 |
| Means of independent variables: | | | | | | |
| $\ln Y$ | 10.717 | 11.083 | 9.485 | 11.176 | 11.199 | 11.058 |
| $\ln P_M$ | .012 | .009 | .022 | .009 | .016 | -.028 |
| $\ln P_K$ | -1.620 | -1.634 | -1.574 | 1.250 | 1.270 | 1.149 |
| $\ln P_L$ | 2.066 | 2.163 | 1.736 | 2.006 | 2.093 | 1.555 |
| $\ln F$ | 15.594 | 15.959 | 14.362 | 4.066 | 4.068 | 4.059 |
| N | 83 | 64 | 19 | 68 | 57 | 11 |

Note: All estimates were obtained by jointly estimating a cost equation, a materials share equation, and a capital share equation by iterated seemingly unrelated regressions, using the SAS SYSNLIN procedure. Standard errors are reported in parentheses.