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On the Contract Curve: A Test of Alternative Models of Collective Bargaining

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The traditional model of collective bargaining confines unions to settlements constrained by the employer's labor demand curve, but an alternative model places wage-employment outcomes on a contract curve that extends beyond the labor demand curve. This paper derives a multidimensional (hedonic) contract-curve model in which employment-security provisions are used to maintain efficient bargains outside the employer's demand curve and distinguishes empirically between the contract-curve and demand-constraint models using data for public school teachers in New York State. Estimates clearly support the contract-curve model over the demand-constraint model by linking the gap between compensation and the value of the marginal product to the strength of employment-security provisions.

Two different models of collective bargaining have been offered as explanations for labor contract outcomes. The demand-constraint model

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sets the employer demand curve for labor as the constraint that faces a union seeking to maximize both compensation and employment (e.g., Dertouzos and Pencavel 1981). Alternatively, the contract-curve model suggests that unions are able, through the use of increasingly effective employment-security provisions, to move beyond the employer demand curve and outward along a contract curve defined by points of tangency between the firm isoprofit curves and union indifference curves (e.g., McDonald and Solow 1981). Employment-security provisions are required for efficient bargains because employment is "excessive" from the employer perspective at every point on the contract curve beyond the demand curve.

This paper extends the contract-curve model presented by McDonald and Solow to include multidimensional (hedonic) contracts and tests the proposition that employment-security provisions are used to move contract settlements beyond the employer demand curve, as predicted by the model. On the basis of detailed data for individual teachers and public school districts, our empirical test rejects the demand-constraint model in favor of the contract-curve model. The only previous test of the contract-curve model, by MaCurdy and Pencavel (1983) for typographical workers, also supports the model but takes a somewhat different approach. Instead of considering the mechanism by which contract-curve settlements are maintained, they simply examine whether the ratio of marginal products approximates the ratio of input prices—that is, whether the wage contains a premium above the marginal product. This paper provides a more stringent test of the contract curve model by requiring that the magnitude of any wage premium be related to the strength of employment-security provisions.

The paper is organized as follows. In Section I we derive both the demand-constraint and contract-curve models and distinguish their predictions. Since our empirical test relies on data for individual teachers and public school districts, we modify the model to apply to this type of public sector activity. In Section II we describe the data and introduce the empirical specification of our tests and then present and evaluate the empirical results. In Section III we consider a number of limitations and extensions of the model to account for a variety of institutional and market settings. A final section provides a brief summary of our conclusions.

I. Theoretical Framework

The proposition that employment-related contract provisions enforce efficient bargains outside the demand curve is tested within the institutional structure of public schools in New York. The bargaining environment in public schools is conducive for testing the two models for reasons that pertain specifically to New York as well as to public schools in general. First, New York State labor laws provide local bargaining units with considerable latitude in the issues that may be negotiated. Second, even though a large majority of local bargaining units in New York are affiliated with a single state-level organization, New York State United Teachers, these local units are free to bargain directly with school districts. This local autonomy eliminates the problem of blanket regional or national contracts. Finally, teacher unions tend to be democratic in making internal decisions and thus tend to represent the preferences of the median teacher.[1]

The feature that distinguishes the contract-curve and demand-constraint models is the role played by the employment-security provisions. Under the contract-curve model, these provisions are needed to maintain employment above the level desired by the employer because compensation exceeds the value of the marginal product. Two types of employment-security rules are important in public schools. The first is a tenure system that constrains the district's employment decisions. Under ordinary enrollment changes, natural attrition of the work force tends to insulate tenured teachers against layoff. The second is the presence in many collective-bargaining agreements of employment-related provisions dealing with reduction-in-force (RIF) procedures and class-size limitations. These provisions may also constrain the district's discretion over employment, particularly under persistent enrollment declines. The effect of declining enrollment on employment, for example, depends on whether a RIF provision is in place.

Under the demand-constraint model, however, employment provisions do not control the level of employment but simply restrict the employer's discretion over the *distribution* of employment and work load (class size). Workers may be interested in such restrictions for a number of reasons—to provide protection (increasing with seniority) against capricious or arbitrary dismissal or to effect a more uniform distribution of work load through class-size restrictions. In the demand-constraint model, variations in these restrictions must be matched by variations in wages, benefits, or employment that are exactly compensating along the employer's demand curve for labor. Hence, the restrictions do not push contract settlements outside the demand curve, as they do in the contract-curve model (creating a premium above marginal product).

Demand-Constraint Model

We obtain a characterization of the demand-constraint model simply by deriving the first-order conditions for taxpayer optimization since contract settlements are constrained to lie along the taxpayer's demand

[1] A more detailed discussion of bargaining in New York school districts is contained in Eberts and Stone (1984).

curve for teacher services. Although taxpayers do not hire teachers directly, we assume that employment decisions regarding teachers are determined indirectly by the preferences and constraints of taxpayers since district administrators act as agents for taxpayers in providing them with educational services. By also assuming that taxpayers as a group make decisions that are commensurate with the median voter, the derivation of the taxpayer utility function can focus on a single taxpayer.[2]

We assume that a taxpayer maximizes utility based on educational services (z) and a composite private consumption good (x) subject to his share of the total district costs (c) and wealth (x_o). Educational services are a positive (and decreasing) function of teachers (T), enrollment (E), and other explicit inputs (A). We assume that T and E are substitutes but that A cannot be substituted for either input.[3] Restrictive employment provisions (P) are assumed to have no direct effect on output but may reduce the productivity of the explicit inputs. The taxpayer's optimization problem is

$$\max V(z, x) \tag{1}$$

subject to

$$z = z(T, E, A, P) \tag{2}$$

$$x_o = x + c[(S + B)T + aA], \tag{3}$$

where a is the price of alternative inputs A.

The first-order condition can be expressed as

$$S = \frac{V_z z_T}{cV_x} - B, \tag{4}$$

where V_z is the marginal utility of educational services, z_T is the marginal productivity of teachers, and V_x is the marginal utility of private consumption goods.[4] The cost-minimizing labor demand curve is the locus of points of tangency between the district isoutility curves and the horizontal salary lines. The demand curve slopes downward due to the concavity of the district utility function. The competitive position is the point on the labor demand curve corresponding to S_o. Again, constraining settlements to the demand curve yields the first-order condition expressed by equation (4).

[2] For a discussion and critique of the use of the median-voter approach to public-sector activities, see Inman (1978). The role of the district administrator as agent for the median voter is similar to the role of the corporate manager as an agent for stockholders.

[3] The separability of A from T and E permits unambiguous predictions for the effects of A.

[4] For simplicity we assume that T is the only choice variable for the district.

Substituting the determinants of V_z, z_T, and V_x into equation (4) and expressing S in traditional logarithmic form, one obtains the quasi-reduced form

$$\ln S = S(\overset{-}{B}, \overset{-}{T}, \overset{-}{P}, \overset{-}{c}, \overset{+}{x_o}, \overset{?}{E}, \overset{-}{a}, \overset{-}{A}) \qquad (4')$$

as an expression of the demand-constraint model. Signs of the partial first derivatives of equation (4′) are indicated above each variable. Most important, employment restrictions (P) must be traded off against salary to the extent that they impose opportunity costs in production.

Contract-Curve Model

In general the demand-constraint model does not yield efficient bargains. Rather, there are salary-employment combinations that are Pareto-superior to combinations on the labor demand curve, but these can be reached only under institutional arrangements that constrain the district's ability to determine the level of employment. Employment constraints are required because employment is "excessive" from the employer's perspective at every point on the contract curve beyond the demand curve. Stated differently, for points along the contract curve the salary (along with other job benefits) contains a premium above the taxpayers' valuation of the marginal product.

A model of efficient bargains is derived by equating the slopes of the union and district isoutility curves with respect to T and S. Consistent with McDonald and Solow, assume that the objective function of the local teacher union is to maximize the expected utility of N teachers, T of whom are employed. If each member has probability T/N of holding a teaching job, the expected utility of a union member is

$$EU(S, B, T, P) = \left(\frac{T}{N}\right)[U(S, B, P) - D] + \left(1 - \frac{T}{N}\right)[U(S_o, B_o, P_o)]. \qquad (5)$$

Thus the utility of a member holding a teaching job is a function of salary (S), other job benefits (B), and employment provisions (P) less the fixed additive disutility of holding the teaching job (D). The utility associated with not holding a teaching job is a function of the salary, benefits, and job characteristics of the next best alternative (S_o, B_o, P_o). Equation (5) can be simplified by assuming that S_o, B_o, P_o, and N are treated parametrically by the union. In this case, $D + U(S_o, B_o, P_o)$ can be set equal to U_o, and we respecify equation (5) as

$$EU(S, B, T, P) = T[U(S, B, P) - U_o]. \qquad (5')$$

The utility function is assumed to be strictly concave with respect to its arguments, yielding downward-sloping, convex indifference curves for S, B, P, and T.

Equating the slopes of the union and district isoutility curves establishes the first-order condition for efficient bargains:

$$S = \frac{V_z z_T}{c V_x} - B + \frac{U(\cdot) - U_o}{U_s}. \tag{6}$$

This condition is identical to that for the demand-constraint model (eq. [4]), except for the nonnegative last term, and corresponds to the MaCurdy-Pencavel (1983) condition for private firms. The presence of the extra term, which represents a premium over the taxpayers' valuation of the marginal product ($V_z z_T / c V_x$), is achieved by contractual constraints on the employer's discretion over employment. With district characteristics given, therefore, employment-security provisions in the contract-curve model are a direct manifestation of union bargaining power. If we express the wage premium (the last term in eq. [6]) as a positive function of such employment provisions (P), substitute the determinants of V_z, z_T, and V_x into equation (6), and again express S in logarithmic form, we obtain the quasi-reduced form

$$\ln S = S(\overset{-}{B}, \overset{-}{T}, \overset{?}{P}, \overset{-}{c}, \overset{+}{x_o}, \overset{?}{E}, \overset{-}{a}, \overset{-}{A}) \tag{6'}$$

as an expression of the contract-curve model that relies on employment provisions to enforce efficient bargains. If employment provisions are present merely to improve workplace equity, as in the demand-constraint model, then the sign of P will be negative to the extent that it reduces the efficiency of productive inputs. If, however, the provisions are present primarily to enforce efficient contracts, the sign of P will be positive. If both explanations are equally important, the effects are canceling, and the effect of P is negligible.

It might be useful at this point to contrast our test of the contract-curve model with the MaCurdy-Pencavel test. They examine the difference between the ratio of input prices and the ratio of marginal products, which indicates whether a significant compensation premium (the last term in eq. [6]) is present. In contrast, our test requires not only that a compensation premium be present but also that the magnitude of the premium be directly related to the strength of employment-security provisions. In the McDonald-Solow model these provisions prevent employers from eliminating the excess employment implied by the compensation premium and, thus, are a direct manifestation of union bargaining power.

Another distinction is that MaCurdy and Pencavel rely on direct estimates of marginal products and input prices (along with assumptions regarding functional form) to test for the presence of a compensation premium. Instead, we rely on quasi-reduced form salary regressions. We take this approach not only because in education many input prices are implicit and marginal products are more difficult to estimate but also because we want to examine the behavioral link between employment-security provisions and the compensation premium.

II. Empirical Test

The demand-constraint and contract-curve models both predict compensating differentials (negative coefficients) for positively valued job benefits, but only the contract-curve model suggests the possibility of *positive* coefficients for the employment-security provisions (P). Thus the signs of the estimated coefficients for P provide a test of the two models: positive and significant estimates support the contract-curve model; negative or insignificant estimates are inconclusive. However, a rejection of the demand-constraint model in favor of the contract-curve model requires not just a positive link between salary and employment provisions but also an inverse link between salary and other positive job attributes. Positive links between salary and positive job attributes are common in the empirical literature on compensating variations, and one should interpret positive coefficients on employment-security provisions as a rejection of the demand-constraint model only if compensating differentials are found for other job benefits.[5]

Specification

To obtain a functional form suitable for estimation, we use an approximation of equation (6′) that is linear in the parameters but not necessarily linear in the variables. We focus especially on the nonlinear interactions suggested by the contract-curve model between the key employment provisions and enrollment trends. Again, these interactions are important in the contract-curve model because, while we expect tenure provisions to be effective in periods of both increasing and decreasing enrollments, we expect RIF and class-size provisions to be effective primarily during periods of decreasing enrollments. All monetary and district-level variables (not already in percentage terms) are expressed in logarithmic form.

[5] Brown (1980) provides both an example and a survey of previous examples of empirical rejection of compensating differentials. Duncan and Holmlung (1983) and Eberts and Stone (1985) present results in support of compensating differentials.

We also consider a number of alternative specifications, including additional nonlinearities in the variables and simultaneity bias. With respect to the first issue, we test for the possible significance of various second-order quadratic terms. To explore the possibility of simultaneity bias, the Hausman (1978) chi-square test for exogeneity is performed. Since exogeneity is rejected for some variables, both two-stage least squares (2SLS) and ordinary least squares (OLS) estimates are presented.

Our analysis is based on data obtained from the New York Department of Education for the school years 1972–73 and 1976–77. From the population of all elementary and secondary classroom teachers we drew a random sample of those who were employed full-time in the same district in both 1972–73 and 1976–77.[6] These data permit a more detailed specification of salary equations than is usually possible. Even so, we exploit the availability of 2 years of data to estimate a fixed-effects model, which accounts for unobserved, but fixed, individual specific (hence also district-specific) variables.[7] As a consequence, variables are measured as the difference between the 1972–73 and 1976–77 values.

Variable names, definitions, and sample means are presented in table 1. The dependent variable is the log-difference in salary between 1972–73 and 1976–77. The independent variables are grouped into four categories: employment-security provisions (P in eq. [6′] interacted with enrollment trends), job benefits (B in eq. [6′]), teacher attributes (to account for teacher heterogeneity), and other district-related variables (related to x_o, E, T, a, and A in eq. [6′]). We assume that changes in c over the period are either zero or uniform across districts, so that these may be ignored in the empirical specification.

The employment provisions (P in eq. [6′]) included in the analysis are tenure, RIF procedures, and class-size limitations. Because of initial interactions with enrollment, the RIF and class-size variables enter our fixed-effects specification in a more complicated fashion than usual.[8] The

[6] The data consist of a one-in-four random sample, excluding teachers in New York City (slightly under 8,000 teachers are included in our sample). Virtually all public school districts in New York State were covered by collective bargaining agreements in both years.

[7] For discussion and application of fixed-effects models, see Antos and Rosen (1975) and Brown (1980). The inflationary trend common to the monetary variables will be captured by the intercept.

[8] Level (nondifference) variables with significant interactions with other variables will not be eliminated by the fixed-effects specification. In finite calculus, e.g., Δy where $y = xz$ is approximately equal to $x\Delta z + z\Delta x + \Delta x\Delta z$. Because we hypothesize significant interactions between enrollment and the RIF and class-size provisions, the interaction between the level form of these variables and the enrollment change also enters the equation. Above, e.g., Δx represents an increase or decrease in enrollment and z the presence of a particular employment provision.

Table 1
Estimates of Salary Equation

			Coefficients	
Variables	Definitions	*M*	OLS	2SLS
Employment provisions:				
Δ*TENURE*	Equals 1 if teacher gained tenure	.264	.025** (10.46)	.027** (9.77)
Decreasing-enrollment districts:				
Δ*RIF*	Equals 1 (−1) if gained (lost) RIF provision	.265	.007** (3.53)	.040** (5.02)
ARIF	Equals 1 if always had RIF provision	.102	.022** (6.82)	.096** (8.00)
Δ*CSIZE*	Equals 1 (−1) if gained (lost) class-size provision	−.062	.006* (2.01)	.048** (4.28)
ACSIZE	Equals 1 if always had class-size provision	.478	.013** (5.88)	.010 (.92)
Increasing-enrollment districts:				
Δ*RIF*	Same as above	.084	.004 (.96)	.005 (.18)
ARIF	Same as above	.033	.022** (3.92)	−.086* (−2.17)
Δ*CSIZE*	Same as above	−.007	−.020** (−3.84)	−1.44** (−3.29)
ACSIZE	Same as above	.156	.005 (1.50)	.048** (3.00)
Job benefits:				
Δ*LEAVE*	Change in number of paid leave provisions	.156	−.002** (−2.62)	.001 (1.07)
Δ*HEALTH*	Change in (log) of cost of health benefits	.682	−.033** (−7.55)	−.054** (−5.07)
Δ*OTHER*	Change in (log) of cost of other pecuniary benefits	.465	−.001* (−1.66)	−.005** (−4.05)

Teacher attributes:				
ΔED	Change in degree attainment of teacher (see text)	.416	.030** (19.22)	.030** (17.40)
$\Delta EDSQ$	Change in the square of degree attainment of teacher	.965	.006** (9.87)	.006** (8.55)
ΔEXP	Change in years of teaching experience	3.929	.013** (3.74)	.013** (3.43)
$\Delta EXPSQ$	Change in the square of years of teaching experience	83.238	−.001** (−33.12)	−.001** (−28.70)
Other district-related variables:				
ΔT	Change in the (log) of the number of teachers	−.055	−3.217** (−11.10)	−6.162** (−2.81)
$\Delta BUDG$	Change in the (log) of the district operating budget	.342	.593** (22.65)	.786** (11.64)
ΔENR	Change in the (log) of student enrollment	−.057	3.667** (12.43)	6.656** (3.08)
ΔA	Change in district expenditures on other inputs	.327	−.264** (−18.52)	−.360** (−11.06)
$\Delta RETAIN$	Change in student retention rate (1 minus the dropout rate)	−.043	−.005* (−2.07)	−.000 (−1.13)
$\Delta WHITE$	Change in percentage of white teachers in district	−.001	−.823** (−5.22)	−.918** (−4.29)
Intercept		...	.304** (49.78)	.277** (25.42)
Dependent variable:				
$\Delta LOGS$	Change in the (log) of annual salary	.342	...	...
R^2	...	...	.436	.382
Observations (N)	...	...	7905	7905

NOTE.—Data provided by the New York State Department of Education. All changes are for academic year 1972–73 to academic year 1976–77. See text for additional explanation of variables; t-statistics are in parentheses.
* Significant at the .05 level (one- or two-tailed test, as appropriate).
** Significant at the .01 level (one- or two-tailed test, as appropriate).

gain or loss of an employment provision is recorded by Δ*RIF* and Δ*CSIZE*, which take the value one if the district gained the provision and the value minus one if the district lost the provision. The presence of a provision in both years is recorded explicitly by *ARIF* and *ACSIZE*, which take the value one if the provision is present in both years. The effect of provisions absent in both years is included in the intercept. The inclusion of *ARIF* and *ACSIZE* reflects the presumption that enrollment changes will have effects that vary according to the sort of employment restrictions present, even if the restrictions do not change. Separate coefficients for decreasing- and increasing-enrollment districts are estimated for the RIF and class-size variables because they are expected to be effective during periods of declining enrollments but relatively ineffective during periods of increasing enrollments. Because we expect tenure to have similar effects in decreasing- and increasing-enrollment districts (an assumption supported in separate results), the variable for tenure (Δ*TENURE*) is not interacted with enrollment. Because no teacher lost tenure in our sample, Δ*TENURE* is either zero or one.

The variables available for job benefits (*B* in eq. [6′]) are change in paid leave days (Δ*LEAVE*), change in the (log) cost of health coverage (Δ*HEALTH*), and change in the (log) cost of other personnel-related expenditures (Δ*OTHER*). All these variables are expected to enter with negative coefficients, reflecting compensating variations.

Our measures of teacher attributes, used to account for teacher heterogeneity, are change in the level of education (Δ*ED*—with less than a bachelor's degree equal to zero, bachelor's degree equal to one, master's degree [or 30 graduate hours] equal to two, and Ph.D. degree [or master's degree plus 30 hours] equal to three), change in education squared (Δ*EDSQ*), change in experience (Δ*EXP*), and change in experience squared (Δ*EXPSQ*).[9] These are standard human capital variables, and for each set of variables the simple change and the change in the squared term are expected to enter with positive and negative coefficients, respectively.

The variables available to control for other district-related variables (T, x_o, E, a, and A) are change in the (log) number of teachers (ΔT), change in the (log) overall district operating budget (Δ*BUDG*) (which is a proxy for changes in x_o), change in (log) enrollment (Δ*ENR*), change in district expenditures on other inputs (ΔA), change in the retention rate for students (Δ*RETAIN*), and change in the proportion of white teachers (Δ*WHITE*).[10] The latter two variables are merely proxies for a

[9] Variation in *EXP* (experience in the district) comes about since some teachers left the district for various reasons during the 4-year period and then returned.

[10] We are unable to separate the effects of A from those of a, the price of A. Fortunately, the sign predictions for the two variables coincide.

number of associated community and district attributes and, therefore, should not be interpreted literally. We also obtain estimates that exclude $\Delta BUDG$, under the assumption that changes in relative wealth (x_o) during the period are either zero or uniform across districts. ΔT, ΔA, $\Delta RETAIN$, and $\Delta WHITE$ are expected to enter with a negative sign, $\Delta BUDG$ with a positive sign.

Results

Both OLS and 2SLS estimates are presented in table 1. Looking first at the OLS results, we find strong support for the predictions of the contract-curve model. First, the coefficient for $\Delta TENURE$ is positive and significant (at the .05 level). Second, in declining-enrollment districts the coefficients for ΔRIF, *ARIF*, $\Delta CSIZE$, and *ACSIZE* are all significantly positive (at the .05 level).[11] Third, in increasing-enrollment districts all but one of the RIF and class-size provisions are either insignificant or consistent with the contract-curve predictions.[12] Thus our hypothesis that RIF and class-size provisions are more restrictive in declining-enrollment districts is supported by the estimates. Finally, an overall test for whether the average (or joint) effect of the employment provisions is positive yields a *t*-value of 8.68 (significant at the .05 level). This finding indicates that the excess of compensation over the value of the marginal product (the last term in eq. [6]) is directly related to the strength of employment restrictions.

The 2SLS estimates also support the contract-curve model. To obtain these estimates, we first performed the Hausman (1978) chi-square test for exogeneity for the various categories of variables.[13] Exogeneity is strongly rejected at the .01 level for ΔT and $\Delta BUDG$, and marginally rejected at the .05 level for the RIF and class-size provisions. Treating

[11] If one estimates a simpler fixed-effects model by deleting *ARIF* and *ACSIZE*, the coefficient for ΔRIF remains significantly positive, but the coefficient for $\Delta CSIZE$ does not—the joint effect is significantly positive.

[12] The exception is the negative coefficient for $\Delta CSIZE$. While we have no obvious explanation for this negative sign, no general problem is suggested because the signs of all the other coefficients for the employment-security provisions in increasing-enrollment districts are either insignificant or significantly positive. This includes the coefficient for change in tenure, which is significantly positive (and the same as the coefficient in decreasing-enrollment districts) if estimated separately for increasing-enrollment districts.

[13] The Hausman test is a chi-square test of whether second-stage predicted variables enter significantly, with exogeneity as the null hypothesis. To perform the test we specified structural equations for the potentially endogenous variables, identifying the system with a geographic "neighborhood" mean for each dependent variable as a way to capture the host of legal, political, and other environmental factors that affect bargaining outcomes. We assume that these neighborhood variables are predetermined for a particular district at a given point in time.

the RIF and class-size provisions, ΔT, and $\Delta BUDG$ as endogenous, we then obtained the 2SLS estimates presented in table 1. The results for the employment provisions are generally similar to the OLS results—$\Delta TENURE$ is significantly positive in both sets of districts, and all but one of the RIF and class-size provisions in decreasing-enrollment districts are significantly positive. Moreover, the 2SLS results provide an even sharper contrast between the two sets of districts since the average effect of RIF and class-size provisions in increasing-enrollment districts is no longer positive. Most important, an overall test for whether the average effect of the employment provisions is positive yields a *t*-value of 2.09 (significant at the .05 level). Thus the 2SLS results also reject the demand-constraint model in favor of the contract-curve model since the employment-security provisions are again directly related to the size of the compensation premium.

Consistent with the predictions of both the contract-curve and demand-constraint models, the OLS and 2SLS coefficients for the job-attribute variables generally indicate significant compensating differentials for $\Delta LEAVE$, $\Delta HEALTH$, and $\Delta OTHER$.[14] With the exception of the coefficient for $\Delta EDSQ$, teacher attribute variables are also all significant with the expected sign.[15] Finally, the results for the other district-related variables are consistent with the predictions of equation (6′)—the coefficients for ΔT, ΔA, $\Delta RETAIN$, and $\Delta WHITE$ are significantly negative (except for the 2SLS coefficient for $\Delta RETAIN$), and the coefficients for $\Delta BUDG$ and ΔENR are significantly positive.

As noted above, we consider a number of alternative specifications. Two of these are additional nonlinearities in the variables and assumptions regarding real wealth (x_o) and its empirical proxy ($\Delta BUDG$). With respect to the first issue, similar results are obtained if additional quadratic terms are also included in the regression. Tests involving second powers of the explanatory variables can also be viewed as an implicit test of the importance of the distinction between a multiplicative and an additive error term, an issue that arises because of possible differences between the nonlinear equation (6′) and our linear estimating equation.[16] Thus the results do not appear sensitive to this distinction.

[14] One may also wonder about the importance of pension benefits. Teachers in New York public school districts are covered by a statewide retirement system in which the local school districts and the state contribute a uniform percentage of the teacher's salary (see Schmid 1971). As one would expect under these circumstances, change in pension cost has no significant effect when entered in the regression because it exhibits no systematic variation across districts.

[15] The positive coefficient for the change in the square of degree status may reflect an additional sort of seniority-based salary premium rather than an actual productivity effect, but the two explanations are indistinguishable in our evidence.

[16] See Judge et al. 1980, pp. 311–14. In a few cases the partial correlation between a variable and its square is nearly perfect, causing both to enter

For the second issue involving real wealth, similar results are also obtained if $\Delta BUDG$ is dropped from the regression under the assumption that relative real wealth is constant during the period.

To summarize, (1) the employment-related contract provisions enter the regression with signs that support only the predictions of the contract-curve model, and (2) the teacher and job-benefit variables all enter the regression with signs consistent with the compensating differentials predicted by both models. The first set of results is consistent with the prediction of the contract-curve model—that, with district characteristics given, stronger employment-security provisions move the contract settlement along the contract curve away from the employer demand curve, increasing the gap between compensation and the value of marginal product. The second set of results reflects compensating differentials, which tends to reinforce the validity of the first set as a discriminating test of the two models.

III. Extensions and Limitations

The model specified in Section I can be extended to a variety of institutional or market settings. Extension of the model to private-sector bargaining, for example, is relatively straightforward. The union objective function can also be modified to account for the possibility that the union may represent only a subset of workers who are already employed and who place no value on the potential employment of other workers. In this case, contract settlements will obviously tend to move toward greater compensation gains (and greater employment losses among nonconstituents) than otherwise.

Another alternative to consider is the argument offered by Hall and Lillien (1979) that unions can move beyond the employer demand curve without the aid of explicit employment-related contract provisions (or at least without provisions contingent on market conditions facing the firm). This would be true, for example, if employees who form the union constituency are nearly indifferent between employment and (temporary) unemployment. As Hall and Lillien point out, public and private unemployment compensation may play a role in establishing this indifference for some industries. The degree to which efficient labor contracts require explicit employment-related provisions depends in part on the market conditions facing the firm. Standard seniority and tenure restrictions (even implicit ones), for example, may be sufficient to establish bargains on the contract curve if the natural attrition rate of the work force and product-market conditions virtually guarantee con-

insignificantly even when the level (or the square) is significant if entered separately. (This is true for T, e.g.)

tinued employment for workers forming the union constituency. In declining sectors, however, more restrictive employment-related provisions may be required.

Results in table 1 can be interpreted as providing some evidence, albeit weak, to support the Hall-Lillien argument—the RIF and class-size provisions (which unlike tenure have effects that are strongly contingent on conditions facing the firm) do appear to play a less significant role in enforcing efficient contracts in increasing enrollment districts. In markets where the period between layoff and recall is shorter than in teaching (where the period is usually as long as a year), the evidence for the Hall-Lillien arguments might be stronger.

IV. Conclusion

Two fundamentally different models of collective bargaining force the question, Do labor contracts place wage-employment outcomes on a contract curve that extends beyond the employer's labor demand curve? McDonald and Solow, relying on employment-related contract provisions to enforce efficient contracts, contend that bargains struck between labor unions and employers are on a contract curve. The more traditional bargaining model, on the other hand, confines unions to a choice set constrained by the employer's labor demand curve. Although the contract-curve model has been used less extensively than the demand-constraint model, it has been the focus of recent attempts to explain real wage movements over the business cycle and implicit contracts. Renewed interest in the contract-curve model, however, has not generated a test of the link between employment-security provisions and efficient contracts.

This paper first derives a multidimensional (hedonic) contract-curve model in which employment-security provisions are used to maintain efficient bargains outside the employer's demand curve and then distinguishes empirically between the contract-curve and demand-constraint models using data for public school teachers in New York State. Our estimates clearly support the contract-curve model and reject the demand-constraint model by suggesting that the magnitude of the gap between compensation and the value of the marginal product is directly related to the strength of employment-security provisions. In addition, the results provide strong evidence of compensating differentials for other teacher and job-related attributes. At this stage of research in this area one should be cautious in generalizing our conclusions. However, our empirical results certainly suggest an important role for employment-security provisions in enforcing efficient contracts, provide a more concrete empirical grounding for theoretical speculations regarding both implicit and explicit contracts, and lend some indirect support to the arguments put forth by McDonald and Solow regarding real wage movements over the business cycle.

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