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ABSTRACT

A "RURAL" TEST OF A PUBLIC EMPLOYMENT MODEL OF SCHOOL DISTRICT EXPENDITURE DETERMINANTS

A public employment model was used to estimate the response of "rural" K-12 Wisconsin school district spending per student to variables such as opportunity wage, tax base per student, number of students, grade composition of students, and grants per student. The magnitude of the resulting expenditure elasticities was small, and some signs differed from a prior study of all K-12 Wisconsin school districts.

A "RURAL" TEST OF A PUBLIC EMPLOYMENT MODEL OF SCHOOL DISTRICT EXPENDITURE DETERMINANTS

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Introduction

Total educational operating expenditures per student can be expressed as the sum of spending for teacher costs and for nonteacher operating costs:

$$E = CT + N \quad (1)$$

where E is total operating expenditures per student, C is average teacher wage plus fringe benefits, T is the number of teachers per student, and N is nonteacher operating expenditures per student (classroom supplies, for example). Variations in educational spending across school districts have been analyzed with respect to determinants of expenditures, determinants of teacher employment levels, and determinants of teacher compensation levels (Bahl, Johnson, and Wasylenko, 1980, p. 137). The public employment approach applied to school finance determinants by Bahl, Johnson, and Wasylenko in "A Public Employment Model" includes analyses of both expenditures for teacher costs (salary and employment levels) and for nonteacher operating costs as components of the total education bill. The approach was illustrated with 1976-77 data from Wisconsin's K-12 school districts.

In this paper, I use Bahl, Johnson, and Wasylenko's public employment model to analyze determinants of Wisconsin "rural" K-12 school districts' educational spending for the 1980-81 school year. A rural school district is defined here as a school district located in a county with a higher percent of population classified as rural than the statewide average percent of population classified as rural (statewide rural average equals approximately 36 percent, based on preliminary 1980 census data). Accordingly, 274 of Wisconsin's 373 K-12 school districts were "rural" in 1980-81. I summarize the model and expected results and describe the data in the next two sections, followed by regression results and analyses of those results, and, finally, conclusions and propositions for further study.

The Model

The public employment model (Bahl, Johnson, and Wasylenko, 1980, pp. 139-143) is based on the assumption that local decision makers choose employment levels and nonteacher operating expenditure levels to maximize a utility function that embodies a trade-off between education services (proxied by teachers employed per student) and local taxes, subject to constraints (for example, money spent in excess of grants must be raised with local taxes). The choices of number of teachers hired and nonteacher operating expenditures enter into the determination of education grants received from the state (Johnson, 1979; Johnson and Collins, 1979), and the number of teachers hired per student enteres into determination of teacher salary levels. Salary levels, employment levels, and nonteacher operating outlays together determine total school spending for current operations. Total school spending minus state school aid determines the local tax bill for education. So, the three components of total educational spending per student (C, T, and N) and state school aid per student (G) are determined, directly or indirectly, by decisions made in local school districts. What variables act to influence the various levels of C, T, and N, and therefore G, that school districts opt for?

The following four equations specify linear relationships between C, T, N, and G and nine exogenous variables. All variable names, definitions and mean values are given in Table 1.

Compensation equation:

$$C = \alpha_0 + \alpha_1 T + \alpha_2 G + \alpha_3 W + \alpha_4 M + \alpha_5 L + \alpha_6 D + \alpha_7 S + \alpha_8 V + \alpha_9 Y + \varepsilon_C \qquad (2)$$

Average compensation level is expected to increase with grants per student, teacher opportunity wages, number of K-12 school districts in the county (a decrease in monopsony power), average number of years local teaching experi-

Table 1: Wisconsin "Rural" K-12 School Districts, 1980-81
Variable Names, Definitions, and Mean Values

Name	Definition	Mean Value
C	Average annual total compensation (salary + fringe benefits) of teachers, 1980-81	$17,447.00
T	Number of full-time-equivalent teachers employed per 1,000 students, 1980-81	65.27
N	Nonteacher operating costs per student, 1980-81 (computed, N = E - CF)	$ 1,164.59
G	*Estimated general state school aid per student, 1980-81	$ 853.29
W	Average weekly wage of finance, insurance, and real estate workers in the surrounding county during the second quarter of 1980, multiplied by 52 to obtain average annual wage (in $1,000)	$ 10.34
M	Monopsony power proxied by the number of K-12 school districts in the county (plus one if any Union High School or K-8 districts)	5.84
L	Average number of years local experience of teachers, 1980-81	9.78
D	Dummy variable for fiscal dependence	.066
S	Number of resident students (actual number plus declining-enrollment increment), 1980-81 (in 100's)	12.11
V	Equalized local property valuation per student, 1979 (in $1,000)	$ 119.336
P	Percent of students attending public school, 1980-81	90.99
H	Percent of students in high school grades (9-12), 1980-81	36.99
E	*Total operating costs per student for education, 1980-81 (includes costs shared by the state and costs exceeding the cost-control maximum)	$ 2,261.55
F	Number of full-time teachers employed per student, 1980-81 (used to compute N)	.063
Y	Net taxable income, 1978, per student, 1980-81 (in $1,000)	$ 17.9266

* Estimated financial data from school district budgets for 1980-81 school year--not final figures.

ence, number of students, equalized property valuation per student, and income per student (G, V, and Y are all measures of ability to pay). No positive or negative relationship is postulated between C and full-time equivalent teachers per student or between C and D (Bahl, Johnson, and Wasylenko, 1980, p. 142). D is a dummy variable representing fiscal dependence--these districts have a fiscal control board that must approve their school budget and school tax levy, in addition to a school board that makes education decisions.

Employment equation:

$$T = \beta_0 + \beta_1 C + \beta_2 N + \beta_3 S + \beta_4 V + \beta_5 P + \beta_6 Y + \varepsilon_T \qquad (3)$$

The level of teacher employment per student generally is related negatively to compensation level, and positively to measures of ability to pay and percent of students attending public schools. No specific relationship is predicted between T and S or N (Bahl, Johnson, and Wasylenko, 1980, pp. 142-143).

Nonteacher operating expenditures equation:

$$N = \gamma_0 + \gamma_1 C + \gamma_3 G + \gamma_4 D + \gamma_5 S + \gamma_6 V + \gamma_7 H + \varepsilon_N \qquad (4)$$

Determinants of nonteacher operating expenditures per student have not been studied sufficiently to yield information upon which to base hypotheses regarding most coefficient signs in the N equation (Bahl, Johnson, and Wasylenko, 1980, p. 143). Grants per student and equalized property valuation per student are measures of ability to pay, however, so nonteacher expenditures per student are expected to rise with G and V.

Grants equation:

$$G = \phi_0 + \phi_1 C + \phi_2 T + \phi_3 N + \phi_4 V + \varepsilon_G \qquad (5)$$

Wisconsin state school aid per student decreases with increasing equalized property valuation per student (V) and increases with total spending per student. Because an increase in T, N, or C contributes to higher per student spending, all else equal, grants very positively with T, N, and C (Johnson, 1979).

Data

There are 373 K-12 school districts in Wisconsin, and 274 of these were defined as "rural" districts for the purposes of this study. Cross-section data for 273 "rural" K-12 school districts were obtained on the exogenous and endogenous variables (one school district had to be dropped from the rural population because a value was not available for an exogenous variable).

Results and Analyses

The simultaneous equation system is overidentified--the average compensation level equation is exactly identified, and the remaining equations are each overidentified. Therefore, the four-equation model was estimated using two-stage least squares (2SLS) regression--estimates of the structural coefficients are shown in Table 2.

The estimation results of the compensation level and employment equations are disappointing--only one coefficient in each is significant at the 5 percent level. Average annual compensation rises approximately $61 with an increase in income per student of $1,000. In the employment equation, an increment in annual compensation of $1,000 results in the hiring of approximately 2 less full-time equivalent teachers per 1,000 students. Each of these significant coefficients affects the dependent variable of its equation in the direction hypothesized.

The nonteacher operating expenditures equation includes one estimated coefficient that is significant at the 5 percent level. Nonteacher operating expenditures per student go up approximately $447 with an additional $100,000 in equalized property valuation per student. This positive relationship between N and V is consistent with greater expenditures per student as ability to pay per student grows.

Table 2: Two-Stage Least Squares Estimation Results of Compensation, Employment, Nonteacher Operating Expenditures, and Grants Equations--273 "Rural" K-12 School Districts, 1980-81.

Compensation

$$C = 16{,}070.00 - \underset{(.74)}{113.34(\hat{T})} + \underset{(.61)}{3.17(\hat{G})} - \underset{(1.63)}{127.42(W)} + \underset{(1.10)}{44.55(M)} + \underset{(1.04)}{251.88(L)}$$

$$- \underset{(1.14)}{423.82(D)} + \underset{(1.16)}{33.93(S)} + \underset{(.68)}{26.76(V)} + \underset{(2.06)^{*}}{60.50(Y)} + r_C$$

Mean value of C = 17,447.0

Standard error of the regression = 1,228.94, n = 273

Employment

$$T = 29.10 - \underset{(1.78)^{*}}{.0019(\hat{C})} + \underset{(1.62)}{.0534(\hat{N})} + \underset{(.64)}{.0760(S)} - \underset{(.44)}{.0210(V)} + \underset{(.27)}{.0279(P)} + \underset{(1.31)}{.3208(Y)} + r_T$$

Mean value of T = 65.27

Standard error of the regression = 10.50, n = 273

Nonteacher Operating Expenditures

$$N = 615.31 - \underset{(.81)}{.0291(\hat{C})} + \underset{(.09)}{1.08(\hat{T})} + \underset{(1.51)}{.5138(\hat{G})} - \underset{(.62)}{34.47(D)} - \underset{(.73)}{1.35(S)} + \underset{(1.66)^{*}}{4.47(V)}$$

$$+ \underset{(.30)}{.90(H)} + r_N$$

Mean value of N = 1,164.59

Standard error of the regression = 187.97, n = 273

Grants

$$G = -942.70 + \underset{(1.95)^{*}}{.0636(\hat{C})} + \underset{(.48)}{6.25(\hat{T})} + \underset{(2.01)^{*}}{1.07(\hat{N})} - \underset{(11.91)^{**}}{8.15(V)} + r_G$$

Mean value of G = 853.29

Standard error of the regression = 245.17, n = 273

-- r_J is the residual for the Jth equation, J = C, T, N, G.

-- The absolute values of t-statistics are in parentheses beneath coefficients.

** significant at the 1% level (one-tail test)

 * significant at the 5% level (one-tail test)

The estimated coefficient signs in the grants equation conform to theory--grants decrease with ability to pay (V) and increase with increases in T, N, and C, the three components of expenditures per student. The coefficients on average annual teacher compensation and on nonteacher operating costs are significant at the 5 percent level, and the coefficient on equalized valuation at the 1 percent level.

How do each of the nine exogenous variables, W, M, L, D, S, V, P, H, and Y affect the endogenous variables C, T, and N and total operating expenditures per student, E? Start with equation (1) and totally differentiate:

$$dE = CdT + TdC + dN. \tag{6}$$

The marginal effect of any exogenous variable, X_i, on E is obtained by dividing equation (6) by dX_i with the following result:

$$\frac{dE}{dX_i} = C\,\frac{dT}{dX_i} + T\,\frac{dC}{dX_i} + \frac{dN}{dX_i}\,. \tag{7}$$

The marginal effect of any X_i on a given endogenous variable is the reduced form coefficient of the exogenous variable, X_i, in the appropriate equation. The reduced form coefficients are given in Table 3; dC/dL = $340.633, for example.

Evaluating C and T in equation (7) at their means and using reduced form coefficients from Table 3, the breakdown of marginal effects of the nine exogenous variables on total operating expenditures per student were calculated and are presented in Table 4.

The final step to obtain total elasticities with respect to the exogenous variables is made by dividing the results of the marginal effects in Table 4 by $\overline{E/X_i}$, according to equation (8) below:

$$\frac{dE/dX_i}{\overline{E/X_i}} = \frac{dC/dX_i}{\overline{E/X_i}}\,\overline{T} + \frac{dT/dX_i}{\overline{E/X_i}}\,\overline{C} + \frac{dN/dX_i}{\overline{E/X_i}}\,. \tag{8}$$

Table 3: Reduced-Form Coefficients--273 "Rural" K-12 School Districts, 1980-81

Variable \ Equation	Compensation	Employment	Nonteacher Operating Expenditures	Grants
Constant	3,934.71	79.80	1,087.33	973.67
W	-172.320	.509	3.481	-4.047
M	60.250	-.178	-1.217	1.415
L	340.633	-1.007	-6.881	8.001
D	1,665.680	-13.330	-190.975	-182.331
S	98.939	-.467	-6.689	-3.803
V	62.690	-.160	-.405	-5.598
P	-12.807	.095	.805	.643
H	-58.599	.393	5.302	4.419
Y	-65.302	.849	7.597	9.308

Table 4: Breakdown of Marginal Effects of the Nine Exogenous Variables on Total Operating Expenditures per Student--273 "Rural" K-12 School Districts, 1980-81

Variable	*Total Effect	=	Compensation Effect	+	Employment Effect	+	Nonteacher Operating Expenditure Effect
W	1.115	=	-11.247	+	8.881	+	3.481
M	-.300	=	3.933	+	-3.106	+	-1.217
L	-2.217	=	22.233	+	-17.569	+	-6.881
D	-314.825	=	108.719	+	-232.569	+	-190.975
S	-8.379	=	6.458	+	-8.148	+	-6.689
V	.895	=	4.092	+	-2.792	+	-.405
P	1.626	=	-.836	+	1.657	+	.805
H	8.334	=	-3.825	+	6.857	+	5.302
Y	18.148	=	-4.262	+	14.813	+	7.597

$E = C\left(\frac{T}{1,000}\right) + N$ (here, $\frac{T}{1,000}$ is full-time equivalent teachers employed per student)

$$dE = dC\left(\frac{T}{1,000}\right) + dT\left(\frac{\overline{C}}{1,000}\right) + dN$$

*$\frac{dE}{dX_i} = \frac{1}{1,000}\left(\frac{dC}{dX_i}\right)\overline{T} + \frac{1}{1,000}\left(\frac{dT}{dX_i}\right)\overline{C} + \frac{dN}{dX_i}$, where X_i is the ith exogenous variable

The computed total elasticities and their components are given in Table 5 (the components are not interpreted as elasticities of C, T, or N with respect to X_i).

The magnitudes of the total elasticities are not large (Bahl, Johnson, and Wasylenko offer the explanation that the tax base equalizing formula used to distribute Wisconsin state general school aid "equalizes" per student educational spending levels among districts and results in small responses in E to changes in exogenous variables). The largest expenditure elasticity, that with respect to income per student, can be interpreted as a .144 percent change in E for a 1 percent change in Y.

Conclusions and Suggestions

In "An Empirical Survey of Studies on Public School Spending," Arthur Denzau stressed that consistency of coefficient signs was important when "testing" a theory of school district spending (Denzau, 1975). Although Denzau compared different school spending models using one data set and I estimated essentially the same model using 1980-81 "rural" data on Wisconsin K-12 school districts that Bahl, Johnson, and Wasylenko applied to 1976-77 data on all Wisconsin K-12 districts, some implications can be drawn from a comparison of elasticity signs between this rural study and the 1976-77 all district study. (The only difference between the variables of the two studies was that Bahl, Johnson, and Wasylenko used percent of teachers working in high school grades and I used percent of students enrolled in high school grades.)

In his survey, Denzau emphasized three variables important in a model used to explain per student current spending, and my model included two of these--percent of students in high school (H) and tax base per student (V). Both these variables had a positive effect on school spending in all studies Denzau surveyed and in this rural study as well. Bahl, Johnson, and Wasylenko also

Table 5: Total Elasticities of Operating Expenditures per Student with Respect to Exogenous Variables--273 "Rural" K-12 School Districts, 1980-81

Variable	Total Elasticity	=	Compensation Component	+	Employment Component	+	Nonteacher Operating Expenditure Component
W	.005	=	-.051	+	.041	+	.016
M	-.001	=	.010	+	-.008	+	-.003
L	-.010	=	.096	+	-.076	+	-.030
D	-.009	=	.003	+	-.007	+	-.006
S	-.045	=	.035	+	-.044	+	-.036
V	.047	=	.216	+	-.147	+	-.021
P	.065	=	-.034	+	.067	+	.032
H	.136	=	-.063	+	.112	+	.087
Y	.144	=	-.034	+	.117	+	.060

-- Components may not sum to total elasticities due to rounding.

$\overline{E}/\overline{W}$ = 218.72 $\overline{E}/\overline{V}$ = 18.95

$\overline{E}/\overline{M}$ = 387.25 $\overline{E}/\overline{P}$ = 24.85

$\overline{E}/\overline{L}$ = 231.24 $\overline{E}/\overline{H}$ = 61.14

$\overline{E}/\overline{D}$ = 34,265.91 $\overline{E}/\overline{Y}$ = 126.16

$\overline{E}/\overline{S}$ = 186.75

found a positive elasticity of total operating expenditures per student with respect to both equalized property valuation per student and percent of teachers employed in high school grades.

In this 1980-81 rural school district study, five of eight total operating expenditure elasticities are positive (the expenditure elasticity with respect to D, a dummy variable, is not being considered), while Bahl, Johnson, and Wasylenko found that all eight elasticities were positive using 1976-77 data on all Wisconsin K-12 school districts. The negative rural expenditure elasticities are those with respect to the monopsony power proxy (M), average number of years local teaching experience (L), and number of resident students (S). In terms of magnitudes of total expenditure elasticities with respect to the exogenous variables, this study and the all K-12 school district study have similar results--the largest spending elasticities are those with respect to equalized property valuation per student (V) and percent of students (or teachers) in high school grades (H), while the spending elasticities lowest in magnitude are those with respect to teachers' opportunity wage (W) and the monopsony power proxy (M).

Although the 1980-81 rural K-12 district study and the 1976-77 all K-12 district study give total expenditure elasticities of similar magnitudes, it would be interesting to apply the public employment model to 1980-81 data for all K-12 school districts and compare the results to the 1980-81 rural results and also to the 1976-77 all K-12 district results. With this comparison, it may be possible to determine whether the differences in total expenditure elasticity signs occur because exogenous variables affect total expenditures differently for rural K-12 districts than for all K-12 districts combined, or because the influence of exogenous variables on total operating expenditures changed from the 1976-77 to the 1980-81 school year. A further comparison could be made by dividing the 373 K-12 school districts into "rural" and "nonrural" categories and comparing the total operating expenditure elasticities obtained using the rural, nonrural, or all K-12 data for the 1980-81 school year.

REFERENCES

Bahl, Roy; Johnson, Marvin; and Wasylenko, Michael. "A Public Employment Model." Chapter 4 in Public Employment and State and Local Government Finance, pp. 136-154. Edited by Roy Bahl, Jesse Burkhead, and Bernard Jump, Jr., Cambridge, MA: Ballinger Publishing Company, 1980.

Denzau, Arthur. "An Empirical Survey of Public School Financing." National Tax Journal, 28, June 1975, pp. 241-249.

Johnson, Marvin B. "Community Income, Intergovernmental Grants, and Local School District Fiscal Behavior." In Fiscal Federalism and Grants-in-Aid, pp. 51-77. Edited by Peter Mieszkowski and William H. Oakland. Washington, DC: The Urban Institute, 1979.

Johnson, Marvin B. and Collins, Judith N. "Fiscal Equity and the Wisconsin School Finance Reform: Nonnegative Aid Constraints," Land Economics, Vol. 5, No. 3, August 1979, pp. 334-349.

DATA SOURCES

Data on variables M, P, S, V, G, T, E, and H were obtained from:

Division for Financial Aids Services. Basic Facts About Wisconsin's Elementary and Secondary Schools 1980-81. Madison, WI: Wisconsin Department of Public Instruction, 1981.

Data on variable D were obtained from:

Division for Financial Aids Services. "Wisconsin School Districts--Types and Numbers." Madison, WI: Wisconsin Department of Public Instruction, July 1, 1981.

Data on variables C, L, and F were obtained from:

Wisconsin Education Association Council. Salaries of Wisconsin Teachers 1980-81, Research Bulletin #80-4. Madison, WI: Wisconsin Education Association Council, April 1981.

Data on variable W were obtained from:

Wisconsin Department of Industry, Labor, and Human Relations. Table 202 in Employment and Wages Covered by Wisconsin's Unemployment Compensation Law, Issue 107, Second Quarter 1980. Madison, WI: Wisconsin Department of Industry, Labor, and Human Relations, December 1980.

Data on variable Y were obtained from:

Wisconsin Department of Revenue. "Wisconsin School District Statistics for 1978." Madison, WI: Wisconsin Department of Revenue, December 1979.