SIMULTANEOUS ESTIMATION OF TEACHER MOBILITY AND READING SCORES

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In an analysis of teacher mobility in San Diego Schools,* it is suggested that the reason for the relation between student achievement and teacher experience is the ability of experienced teachers to move to the more attractive schools (where the high achievers go). That report promised further investigation of the relation between reading scores and teacher mobility. This note uses two-stage least squares (2SLS) to better estimate the interactions.

Fundamental to the validity of ordinary least squares is the assumption that the independent variables are uncorrelated with the stochastic disturbance. This assumption is violated whenever the single equation being estimated by ordinary least squares belongs to a system of simultaneous equations, i.e., a system of stochastic relations which each observation is required to satisfy. The applications of ordinary least squares to one equation in a system of simultaneous relations produces inconsistent estimates of the equations parameters. Roughly speaking, an estimator is consistent if its probability distribution becomes more concentrated about the parameter of interest as the sample size increases, where in the limit (infinite sample size) all of the distribution's mass is concentrated on the single parameter. Consistent estimators of the parameters of a simultaneous equation system can be obtained if ordinary least squares (OLS) is replaced by a simultaneous equation estimation procedure.

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*An Analysis of Teacher Mobility in San Diego Schools, D. Greenberg, J. McCall.

The simultaneous estimation problem may be important in the analysis of teacher mobility. Our main interest generally in schools is how well they do the job of teaching -- thus, a major reason for interest in teacher mobility is its effect on the education of students. A persuasive argument can be made that the average reading ability of students at a specific school depends on the degree of teacher movement from the school.

While movements during the school year should be especially upsetting to students, any school which exports a large number of teachers will generally get young and inexperienced teachers as replacements. The connection between turnover and reading ability will be stronger if there are school characteristics, such as a poor plant, or location near an airport, that are detrimental both to teacher satisfaction and student learning.

On the other hand, the movement of teachers among schools depends on reading ability and factors related to it such as the race and socioeconomic status of the students at the school. In general, the schools where students possess high reading ability are more attractive to most teachers. Thus, reading ability and teacher movement are jointly determined. If we let Y_1 and Y_2 denote average reading ability at a school and the mover variable ($Y_2 = 1$ if a teacher moves, $Y_2 = 0$ if the teacher doesn't move), respectively, we might try the following system of simultaneous equations:

$$Y_1 = \alpha_0 + \alpha_1 Y_2 + \varepsilon_1 \qquad (1)$$
$$Y_2 = \beta_0 + \beta_1 Y_1 + \varepsilon_2 \ .$$

The application of OLS to each of these equations gives inconsistent estimates of the α's and β's. Because the equations are essentially identical, we cannot use 2SLS.* To remedy this, we introduce the three exogenous variables: X_1 -- percent of AFDC students, X_2 -- teacher experience, X_3 -- teacher experience squared, and apply 2SLS to estimate the α's and β's in the following system:**

$$Y_1 = \alpha_0 + \alpha_1 Y_2 + \alpha_2 X_1 + \epsilon_1 \qquad (2)$$

$$Y_2 = \beta_0 + \beta_1 Y_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon_3.$$

Table 1 reports the 2SLS estimates of the α's and β's and also the OLS estimates obtained when each equation in (2) is estimated separately by OLS. This was done for elementary schools, junior high schools and senior high schools. The OLS estimates of α_2 and β_1 are negative and highly significant at all three levels of schooling. Reading ability is strongly and negatively related to the social class of students and teacher movement is negatively related to reading ability. A new structure emerges from the 2SLS analysis. The estimate of α_1 becomes large, negative and significant. The estimate of β_1 increases and becomes more significant. The estimates of β_2 and β_3 remain insignificant, which suggests that the reason more experienced teachers don't move as much is not their inertia, but that they are already at the schools they

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*This is the "identification" problem. For a discussion of two-stage least squares estimation see Dhrymes, Econometrics, Harper & Row, 1970.

**The percent AFDC is a measure of the students from poor backgrounds (i.e., of the student input into the school process). The measures of teacher experience are intended to measure ability of the teacher to transfer.

like. To put the size of α_1 and α_2 into focus, note that the worst sixth of San Diego elementary schools (in terms of subjective ranking), have percent of AFDC 30 percent higher than the best, and turnover rates approximately 5 percent higher. Thus, the reading scores of those groups of schools will differ by (.05 x 83.6) = 4 points because of teacher turnover, and 30 points because of student backgrounds. The reading parameter β_1 accounts for all of the 5 percent difference in turnover. The analysis suggests that teacher turnover is a serious problem, but that the major reason for the relation between experience and achievement is the ability of experienced teachers to get to the schools of high achievers.

Table 1

OLS + 2SLS ESTIMATES OF TEACHER MOBILITY AND READING SCORES

	Esti-mate	Parameter						
		α_0	α_1	α_2	β_0	β_1	β_2	β_3
Elementary Schools	OLS	49.8	-.26 (.3)*	-1.13 (65)	.13	-.0008 (2.5)	-.0014 (.7)	-.00003 (.4)
	2SLS	55.7 (20)	-83.6 (2.2)	-1.01 (15.2)	.14 (7)	-.0012 (3)	+.00006 (.02)	-.00008 (.8)
Junior High Schools	OLS	65.8	-.29 (.4)	-1.68 (80)	.17	-.0012 (3.0)	-.006 (2)	+.00008 (.6)
	2SLS	66.8 (128)	-31 (2.7)	-1.59 (37)	.17 (7)	-.0014 (3.6)	-.0057 (1.8)	+.00007 (.6)
Senior High Schools	OLS	69.6	+.7 (.7)	-2.33 (70)	.1	-.0008 (2)	-.0012 (.4)	-.00003 (.3)
	2SLS	71.7 (48)	-75 (1.6)	-2.11 (13)	.12 (4)	-.0012 (2.7)	-.0006 (.2)	-.00005 (.4)

*The numbers in parentheses are the t-statistics.