ECONOMY OF SCALE IN THE PRODUCTION OF SELECTED EDUCATIONAL OUTCOMES*

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Introduction

In this study, the authors sought to examine the concept of economy of scale as it relates to school systems. We consider this as a part of a broader theoretical question, namely the identification of relevant factors which in some way contribute to the production of educational outputs. In the instance where the system under examination is a school or school district, then we may think of there being two kinds of inputs to the system: (1) student inputs, and (2) financial inputs. Within the system, the two types of inputs can be combined or manipulated in many different ways. In a school or school district the administration makes decisions on (1) the manner in which funds will be utilized, (2) the way in which student inputs will be arranged

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or grouped, and (3) the variety of interactions that will be produced between students and the things that money can buy. These three kinds of things we call the manipulatable variables within the system, even when we recognize that there are degrees of decision responsibility which allow or do not allow the administrator (broadly construed) to manipulate these characteristics. From the administrator's standpoint, the student input is relatively fixed as is the financial input at any given time. Thus, the administrator's concern in attempting to consider the problem of maximizing educational outcomes is related to the utilization of alternative manipulatable characteristics when inputs to the system are considered as held constant.

The specific manipulatable characteristic under examination in this study is size of school district. Intuitively we would expect that there would be economies associated with larger school districts which would have greater beneficial effects on educational outcomes in larger school districts. This has been partially substantiated by the research evidence. Unfortunately the major studies which have considered size of school district (the economy of scale question) have confined themselves to simply examining whether larger school districts are related to lower financial inputs when student inputs are held constant. For example, a study by Hanson (1964) demonstrated that there were significant economies of scale. Although the Hanson study considered the effect of student inputs and various external systems, there was no measure of educational outcome. A study by Werner Hirsch (1959) carried out in twenty-seven St. Louis

school districts noted a significant negative relationship between size of school district and an outcome measure. However, his "scope and quality of education" measure which might have been considered as an outcome of the system was so much a direct function of student inputs and system characteristics as to make it inappropriate for consideration as an outcome measure.

In a recently completed study, the Government Consulting Service of the Fels Institute of Local and State Government (1964) examined twelve social economic characteristics of communities (student input and external system characteristics) and related them to mean achievement test scores for the school districts of Pennsylvania. They noted relatively low multiple R scores in the regression equations for other than the large city school districts.

Thus, they ran a separate regression equation using average achievement test scores as the criterion measure and selected two new independent variables. The first independent variable was a measure of financial input to the system and the second, a measure of district size (average daily membership). In part, they concluded:

> "There is an indication, therefore, that average achievement test scores may be directly related to size of administrative unit, holding constant the factor of per pupil input in terms of dollars. This suggests that the small size of the educational administrative unit found typically in small rural communities may be inefficient." (Government Consulting Service, 1964, P. 25)

Unfortunately, they used average achievement test scores as the criterion measure rather than residuals from the preceding analyses. Thus, there is no evidence whether size of district might

be accounted for in its predictability by its intercorrelation to various of the social economic variables used in the first analyses. Stated differently, we are not aware from that study whether size of district makes an independent contribution in predicting the criterion measure.

Methodology

We sought, in this study, to examine the relationship between size of school district (ADA) and several measures of educational outcome (mean and median reading and arithmetic scores at the 5th grade) while controlling statistically for student and financial inputs (sccio-economic characteristics of communities and dollar expenditure per ADA, respectively). The population included all California school districts with elementary school programs, which were within Standard Metropolitan Statistical Areas of the State in 1960. A grouping variable was used to distribute the 245 school districts by type of district [Elementary District K-6 (designated as Grade Span 1), Elementary District K-8 (GS 2), Unified District (GS 3)]. Separate analyses were made for the three with the following number of cases in each grade span: GS 1 - 34 school districts, GS 2 - 176 school districts, GS 3 - 35 school districts. This distinction between the three types of districts was considered to be necessary because of the differences between these district types in student ADA (district size) and in the possible differing effects of organizational characteristics on the criterion measures.

The ten measures used as independent variables in the study

were derived from census data and from financial data available about the California school districts. Of the ten variables, eight represented socio-economic measures which were believed to be descriptive of the students, and of the community (student input); one variable was a measure of financial resources available to the school district (financial input) and one was a manipulatable characteristic of the system (ADA).

All of the data used in the study were for the same time period. We considered either data for the year 1960, or data which indicated the change, along some dimension, for the three-year period 1957-1960. Districts were defined, for data collection purposes, by taking the closest geographic approximation to the actual district using census tract data.

Within each of the three grade spans, stepwise multiple regression equations were used to predict each of the four criterion measures from the eight student input measures. Then, for each of the twelve equations (three grade spans, four criterion measures), we entered an additional variable--a financial input measure, and allowed the computer to select this variable along with the others, in the twelve new regression runs. Finally, we "forced" an additional independent variable--size of district (ADA)--to determine whether the introduction of the new variable increased the multiple R^2 of the equation. And, if predictability was increased, we hoped to examine the nature of the linear relationship as expressed by the regression coefficient for the forced variable.

Findings and Conclu icns

The results of these analyses are summarized in Table I. In this table, row labels indicate independent (predictor) variables, and columns represent the separate dependent variables. Within each column, an asterisk (*) indicates that the corresponding row variable was entered and retained in the regression equation as reliably (significantly) related to the dependent variable. Multiple R^2 are also reported in Table I for each dependent variable at each of the three stages (Run 1 with eight student input variables, Run 2 with total expense/ADA added, and Run 3 with ADA forced).

Multiple R^2's of the twelve original equations ranged from .37 to .69, and ranged from .35 to .73 when the size variable was introduced. One of the most interesting results of these analyses is that neither the financial input variable or the district size variable, showed any significant linear relationship to any of the student output measures for grade spans one and two. Moreover, the net effect of "forcing" these variables into the equations was an increase in the standard error of estimate and a decrease in the explained variance.

On the other hand, the size of district appears potentially related to output measures for grade span three. Furthermore, these linear equations are significantly more reliable than those obtained for GS 1 and 2, ranging from 69 to 73 percent explained variance (GS 3), as opposed to 37 to 51 percent (GS 1 and 2).

Introduction of the size variable yielded the following tentative conclusion: Given the equivalent financial resources

and comparable socio-economic characteristics, there is no evidence that greater educational benefits are produced in larger school districts with elementary school programs (within the size range of districts included in this study).

Final Notes

The existence of a nonlinear relationship between ADA and the outcome measures could of course confound the findings to make ADA appear unrelated. Thus, we are presently in the act of examining the same data using nonlinear regression techniques. (And, I might tentatively note, that for the several runs that we have already made, it appears that prediction will be increased substantially.) There is one problem, however, that seems quite apparent from the examination of this data. Student input measures are such powerful predictors that it is quite possible that a school district characteristic like ADA would provide no additional explanation in the prediction equation even though this variable might have a differential relationship to various sets of students or to various kinds of conditions. That is, it is possible that one range of district size might be appropriate for one set of students, where another range of district size might be appropriate for another set. We have begun consideration of differential impact of the ADA variable, by using the student input variables in the nonlinear equation presently under consideration, to develop clusters of school districts with similar community attributes for consideration in individual prediction models.

TABLE I Summary of Results of 12 Multiple Regression Equations Predicting Student Output from Measures of Student and Financial Input (Alkin, Benson, Gustafson)

Independent Variables	Dependent Variable: GS I n = 34				GS II n = 176				GS III n = 35			
	Math		Reading		Math		Reading		Math		Reading	
	MDN	$\bar{x}$	MDN	$\bar{x}$	MDN	$\bar{x}$	MDN	$\bar{x}$	MDN	$\bar{x}$	MDN	$\bar{x}$
1. % Professional			*	*	*	*	*	*			*	*
2. % Unemployed	*						*		*	*	*	*
3. %Other Employed	*								*	*		
4. % Under 18 at home	*	*	*	*	*	*			*	*		
5. %Own homes						*	*	*				*
6. Median income		*										*
7. Median educ. of par's			*	*	*	*	*	*				
8. Median home value					*	*	*	*	*	*		
R^2	.37	.44	.47	.48	.46	.51	.49	.49	.69	.68	.66	.62
9. Total exp./ADA	*										*b	*c
R^2	.37[a]	.44	.47	.48	.46	.51	.49	.49	.69	.68	.68	.64
ADA	+	+	+	+	+	+	+	+	+	+	+	+
(other variables accepted)	2,3,4,9	4,6	4,8	1,4,7	1,4,7,8	1,4,5,7,8	1,2,5,7,8	1,5,7,8	2,3,4,8	2,3,4,8	1,2,5,6,9	1,2,5,6,9
R^2	.35	.42	.43	.46	.46	.51	.49	.48	.69	.70	.73	.71

*indicates variable was accepted and retained in the regression equation
+indicates variable was forced into the regression equation
a) R^2 slightly larger than previous R^2, but rounds off to .37
b) % own homes and median income also included
c) % own homes also included

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