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ABSTRACT

This paper examines the relationship between school size and student achievement in California elementary schools with varying student characteristics and urban/rural locations. Previous research on school size addressed questions of scale economy, efficiency, and equity, but was not conclusive regarding the effect of elementary school size on student performance. For this analysis, data on 4,337 California K-6 schools included third-grade mean scores on the California Assessment Program for 1986-87; total enrollment; percentage of students whose families received Aid to Families with Dependent Children; percentage of students with limited English proficiency; and school location (urban, suburban, or other nonurban). Results of stepwise linear regression, one-way analysis of variance, and trend analysis indicate that larger schools are not associated with improved student performance, even when comparing schools with similar student characteristics. In fact, for urban schools serving high percentages of students in poverty, school size and student performance displayed a negative linear relationship, with student performance best in schools with under 200 students. For schools serving low percentages of students in poverty, student performance may be best in the middle range of size (200-800 students). A linear and quadratic function appears to best represent the relationship between school size and achievement for all schools and for all urban schools, while linear functions best represent the relationship for suburban schools and for other nonurban schools. Contains 60 references and 18 data tables and figures. (SV)

The Relationship Between Elementary School Size and Student Achievement

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Statement of Purpose

The purpose of this research is to examine the relationship between school size and student achievement at the elementary school level. The study first addresses whether or not the size of an elementary school is associated with differences in student characteristics. Secondly, an efficiency analysis appraises the relationships between school size and student achievement. Differences among schools in urban and non-urban settings as well as differences among schools serving varying levels of students in poverty are described. Finally, a trend analysis explores whether a linear or some non-linear function best describes the relationship between school size and student achievement. The study uses data for all kindergarten through sixth grade California public elementary schools.

Summary of the Literature Review

One recurrent assertion in the research regarding school and school district size has been that larger schooling units make education less costly to the taxpayer and more effective in providing educational benefits to the students (Callahan, 1962; Conant, 1969; Tyack, 1974). It is important to note that the literature on scale economy addresses two major issues. One is concerned with the relationship between cost of production and size of the production unit. The other is concerned with returns to scale as measured by the quality of the outcomes. More research has been undertaken on the former issue than the latter.

The bulk of the research on economies of size as related to the cost of educational services has concentrated on the average per pupil cost savings of school or school district consolidation. The notion of a U-shaped curve to describe the relationship between school district size and per pupil cost was advanced by Cohn (1975). A review of 35 studies of economies of size in education conducted by Fox (1981) revealed that generally a U-shaped curve best characterizes the average per pupil costs associated with changes in unit size. However, Fox points out that many of the economy of scale studies of schools underestimate the costs of larger schools since many of the administrative and support service costs of larger schools are borne by the district rather than the school. Riew (1986) compared scale economies in elementary school settings with secondary school settings. He noted cost savings related to increased school enrollment for both levels and concluded that savings due to economies of scale are greater for secondary schools than elementary schools.

The research on economies of scale as it relates to cost savings has been criticized on several fronts. One problem noted is that of incomplete accounting of educational costs. A major criticism is that many economy of scale studies do not take into account the increased transportation costs related to school or school district consolidation (Kenny, 1982 and Monk, 1984). Additionally, most scale economy studies do not estimate capital outlay savings (Riew, 1986) that are conceivable with larger schools. Studies do not account for the impact on local communities when schools or school districts consolidate (Day, 1980). A study of school district size (Bilow, 1986) which examines both economic and psychological perspectives points out that costs of communication and coordination of effort increase with increased school size. Such possible costs are difficult to measure and have not been included in the quantitative research. Finally, studies which examine cost savings at the district level do not track how those savings are distributed to individual school sites (Monk, 1990).

A much smaller portion of the literature on scale economies examines efficiency issues such as the impact of size on student achievement. Most of the research in this area is predicated on the assumption that larger schools benefit from increased returns to specialization. That is, the number of students to be educated influences the range of courses offered at an affordable price and affects the ability of the school to retain teachers who are more highly specialized in delivering the type of instructional services they provide. These two factors are assumed to assist in rendering the school more efficient and effective. Most of the literature investigating returns to specialization has focused on secondary and higher education levels, using the district rather than the individual school as the unit of analysis. The rationale for concentration at the high school and postsecondary levels has been that greater opportunities exist for taking advantage of economies of scale and returns to specialization as student interests, subject matter, and instructional environments become more complex and diverse.

Some early research suggests that school size is positively related to achievement (Coleman, 1966; Summers and Wolfe, 1977). However, research efforts in this area are limited and results are mixed with regard to the type of relationship between school and/or school district size and educational outcomes. Several studies point to the possibility that large institutions are not consistently associated with improved student performance. Keisling (1967) examined the relationship of high school size and student achievement while holding measures of student ability and socioeconomic status constant. He found a negative relationship between school size and school quality, and concluded that the evidence suggested caution regarding the massive school consolidation movement underway when the research was conducted. On the other hand, another study of high schools during the same period (Burkehead, Fox, and Holland, 1967) found no statistically significant relationship between school size and measures of test scores, dropout rates, and post high school educational intentions.

In their 1967 book, *Big School, Small School--High School Size and Student Behavior*, Barker and Gump examine the relationships between high school size and the scope of academic program offerings. They concluded that "the smaller schools were deficient, in comparison, with the larger schools, with respect to specialized mathematics, specialized social and behavioral sciences, foreign languages, and specialized business classes". However, they also found some of the curricular content of the specialized classes being covered in other related courses in smaller schools. The two researchers also concluded that increased extent of curricular scope was not nearly proportional to increased high school size. Their study also compared the participation and satisfaction levels of students attending large and small high schools. They concluded that students in smaller schools participate more in a wider variety of school activities than students in larger schools. It was also noted that the educationally disadvantaged student in a smaller school experienced as much incentive to participate as the nondisadvantaged student.

In research conducted twenty years since the Barker and Gump investigation. David Monk (1987) draws a similar conclusion. He noted that gains made in curriculum comprehensiveness due to increased high school size beyond a modest level of enrollment are minimal. He concluded that "the case for maintaining secondary school enrollments at the 400 pupil level is convincing; the case for maintaining secondary school enrollments beyond 400 is more problematic."

In a study of all New Jersey school districts. Walberg and Fowler (1987) examined the relationship of district size on per pupil expenditure and on student achievement. While they found a positive correlation between district size and per pupil expenditure. they also found a moderate. negative correlation between district size and achievement. The study used school district size rather than individual school size. thus making it unclear as to whether the reported effects are due to district size or to the higher concentration of larger schools within large districts. The researchers suggested that. given the results of district level data analysis. additional investigations of the relationship between school size and achievement were warranted.

Studies examining the relationship between school or school district size and educational outcomes at the elementary school level are few in number. One 1968 study (Alkin. Benson. and Gustafson) found no statistically significant relationship between school district size and achievement in elementary grades one through three. Michelson (1972) analyzed the relationship between elementary school size and sixth grade reading scores. He found a negative, but statistically insignificant relationship in his sample. Edington and Martellaro (1984) examined four years of data from New Mexico elementary and secondary schools and found no significant relationship between size and achievement.

Eberts (1984), using a nationwide sample of 338 elementary schools, studied the relationship between school size and student achievement in mathematics. He found that the difference in student mathematics achievement between small schools (enrollment under 200 students) and medium size schools (enrollment between 200-800 students) is not significant, but real differences in achievement exist when comparing medium size school with large schools (enrollment above 800 students). Eberts found a strong negative association between large schools and student performance and suggested additional investigation into other factors which may account for differences in achievement in schools with enrollment over 800 pupils. A study of fifty London elementary schools (Mortimore, et al. 1988) revealed no positive relationship between larger schools (enrollment over 160 pupils) and student progress. The researchers found positive relationship between elementary schools of 160 enrollment or less and pupil progress in cognitive areas. The study concludes that there is "no evidence from the Project's findings that larger schools were associated with better progress in any area."

Some research seems to indicate that larger schools do not necessarily take advantage of the benefits possible given returns to specialization. In a discussion of scale economy research, Monk (1990) draws the distinction between economies of scale which are theoretically possible and those which are actually undertaken by schools and/or school districts. Monk's assertion is that many schools do not take advantage of the economy of scale incentive and, as a result, actual differences due to size are minimal.

Results from the few studies of scale economies at the elementary school site level which have been conducted do not present strong evidence regarding the existence of scale economies or diseconomies. However, it is difficult to compare the results of economy of scale studies in education because the investigations often differ in the unit of analysis. These differences include the grade levels studied and whether the analysis compares individual schools or school districts. Methodological differences also exist in that the variables used for modeling educational inputs and outputs often vary greatly among studies.

The existence of some cost savings related to size are generally supported by the research, but nevertheless, results of these studies are not overwhelmingly consistent regarding the exact nature of the savings. There is little consensus in the research regarding scale economies as measured by differences in student achievement, particularly at the elementary school level. In part, the difficulties present in the investigations of the relationship between size and student performance also surface in studies of educational productivity, or efficiency.

Most studies of educational efficiency have a portion of their conceptual framework grounded in the microeconomic theory of the firm. The basic premise is that a function can be determined which minimizes the cost of the production of educational outputs. However, several problems exist in applying microeconomic theory to public sector service provision. The major difficulty is that no universal agreement regarding a single production model for educational services exists. An additional problem is that of indivisibilities, that is, there are a number of human and capital resources used in the production of education that cannot be easily divided into discrete, per pupil units. Most of the efficiency research examines the relationship between expenditures and performance.

Reviews of the research on the relationship between per pupil expenditures and achievement have demonstrated a consistent lack of consensus regarding results (Hanushek, 1986; Childs and Shakeshaft, 1986; Walberg and Fowler, 1987; Mac Phail-Wilcox, 1986). In a recent article on this subject, Eric Hanushek (1989) concludes: "There is no strong or systematic relationship between school expenditures and student performance." However, Stern (1989) notes that a majority of the production function studies do not account for educational costs in comparable ways, specifically with regard to per pupil expenditures on teacher salaries, the largest single component of educational cost. Stern concludes that until production function research uses systematic and consistent measures of the various components of teacher cost (e.g., experience, education, starting salary) the results of this research will likely continue to be confusing and contradictory.

Most of the efficiency research uses school district level data either exclusively or in combination with data generated at the school site level. In recent years increased attention has been directed to microanalytic analysis as more appropriate for efficiency and effectiveness investigations (MacPhail-Wilcox, 1986; Monk, 1990). This usually refers to the examination of data collected at the school, classroom, or individual student level.

For the purpose of this study, the literature on educational production functions provides a framework for the development of a model of the educational process that is applicable to the investigation of the relationship between school size and student achievement. A significant, consistent result in the research on efficiency is the overwhelming importance of measures of student socioeconomic status as a predictor of student performance (Coleman, 1966; Hanushek, 1986; Walberg and Fowler, 1987). This points to the need for measures of student background characteristics as essential variables in a model of the educational process.

The research on school size address questions of scale economy, efficiency, and equity. The existing research varies in conceptual design and methodology as well as in the units for analysis. In sum, previous research regarding the relationship between elementary school size and student performance is not conclusive.

Study Approach

For the purpose of this study school size is viewed as an intermediate variable which is associated with factors related to student achievement. The questions to be considered are as follows:

- What is the relationship between school size and student characteristics?
- Are there differences in student performance among different sizes of elementary schools?
- Do differences exist in the relationship between school size and student achievement when comparing schools in urban, suburban, and other non-urban locations?
- What is the relationship between school size and student performance among schools serving students with similar background characteristics?
- Which type of linear or non-linear function best represents the relationship between school size and student performance?

These research questions explore the issue of an optimum size for elementary schools as it relates to student performance. The research is intended as a descriptive rather than a predictive endeavor and uses the school site as the unit of analysis. The study does not address the relationship between cost and school size. For the schools examined in this study, available data related to per pupil expenditures represents only district average per pupil costs. Average district expenditures do not address the issues of differences in resources among schools within the same district. Consequently, this level of financial data is not adequate to address the issue of cost savings associated with the individual school site.

The question of the existence of a scale economy raises the issue of whether or not a linear function is the best choice for a model to describe the relationship between school size and student performance. The investigation of the existence of some type of scale economy implies that both increasing and decreasing returns to scale may exist within the same data set. This notion of returns to scale provides a theoretical basis for assuming that a non-linear function may exist. Consequently, linear regression, although often used in previous research investigating the question of size and achievement, may not be the most applicable analytic model. In this research, trend analysis is conducted to address the question of whether a linear or non-linear model best represents the relationship between size and achievement. Trend analysis assists in the description of a data set by testing for statistical significance for linear, quadratic, cubic, and quartic functions (Marascuilo and Serlin, 1988; Keppel, 1892).

Methodology

Overview

In addressing the relationship between school size and student performance, it is important to also know if student characteristics differ among various levels of school size. The analysis conducted in this study examined differences in student characteristics and student performance among five enrollment size categories. Subsets representing three different school types (urban, suburban, and other non-urban) and six categories of percent of students living in poverty were also examined for differences in student characteristics and student performance. The amount of variance in student characteristics and student performance explained by differences in enrollment category was calculated. Regression analyses were conducted to assess the relative importance of each variable in explaining the variance in student performance scores across size categories. A concluding analysis tested whether a linear, quadratic, cubic, or quartic function best represented the relationship between school size and student performance.

Description of the Variables

The mean score of the third grade reading, writing, and mathematics tests of the California Assessment Program for the 1986-87 school year was used as the independent variable for student performance (CAP mean). The California Assessment Program uses matrix sampling methods and is designed to represent the school-wide rather than the individual performance of students in the grades for which the tests are administered.

The dependent variables are total school enrollment (ENROLL), the percentage of students in the school who are limited-English speakers (LEP),and the percentage of students in the school whose families receive Aid to Families with Dependent Children (AFDC). The continuous variable ENROLL was converted into a categorical variable representing five size categories as follows:

Enrollment Category	Total School Enrollment
1	1-200
2	201-400
3	401-600
4	601-800
5	801 and above

The AFDC variable was also converted to a categorical variable representing six categories as described below:

AFDC Category	Percent of AFDC Students at the School
1	0-5%
2	6-10%
3	11-15%
4	16-20%
5	21-25%
6	26% and above

This study included data from 4337 California kindergarten through sixth grade elementary schools. Subgroups were also identified for three school types: 1) urban, 2) suburban, and 3) other non-urban. Table A-1 displays the frequency distributions for all schools in the study according to enrollment size, school type, and AFDC Category. Descriptive statistics for CAP Mean, AFDC, and LEP variables by Enrollment Category and school type are provided in Table A-2. Descriptive statistics for CAP Mean and LEP variables by AFDC Category and Enrollment Category are displayed in Table A-3. Table A-4 contains a simple correlation matrix for all variables.

Analytic Approach

Stepwise linear regression was first used to examine three continuous quantitative variables related to student achievement: AFDC, LEP, and ENROLL. Regressions were calculated for all schools in the data set as well as subsets of schools by school type, enrollment category, and AFDC category. Variables were not forced into the regression equations.

Next, one-way Analysis of Variance (ANOVA) was conducted for all schools in the data set as well as for the data subsets used in the regression analysis. One purpose for this set of analyses was to determine if there were significant differences in student characteristics and student performance for each enrollment size category. Differences in student characteristics and student performance among the three school types and among the six AFDC categories were also examined. Post hoc pairwise contrasts were used to examine differences in the means of the AFDC, LEP, and CAP Mean variables. These contrasts were conducted for the five size categories by the three school types and by the six AFDC categories. Scheffe' values were used to test for significance at the .05 level and mean differences were calculated for the significant contrasts. Another purpose for the ANOVA analysis was to examine the amount of variance in student achievement and student characteristics which is explained by enrollment category. The statistic η^2 was calculated to measure the percent of variance in CAP Mean, AFDC and LEP which is explained by enrollment category (η^2).

Finally, trend analysis was conducted to determine if a linear, quadratic, cubic, quartic or some combination of these functions best described the relationship between school size and student achievement. Tests for trend were conducted for all schools in the data set, and those results were compared to results for the subsets of school type and AFDC category.

Discussion

The findings from the analyses conducted are discussed below in the following order: 1) findings from the stepwise regressions, 2) findings from the ANOVA comparisons, and 3) findings from the trend analyses. Next, these findings and their implications are summarized for all analyses and suggestions for future research are outlined.

Findings from the Stepwise Regressions

Results from fifteen stepwise regressions for all schools and for subgroups of schools by Enrollment Category, by school type, and by AFDC Category are depicted in Table B-1. The table displays the variable entered in each step, the R^2 value for Step 1, the change in R^2 values for Steps 2 and 3, the total R^2 for the equation, and the coefficients for each variable.

The stepwise regression conducted for all schools in the data set indicates that the percent of students in the school whose families receive AFDC is the variable which was most important of the three variables entered in to the equation in explaining the variance in CAP Mean (Step

1). Step 2 in the regression was the LEP variable, followed by enrollment. The enrollment variable accounted for less than one percent of the explained variance in CAP Mean scores.

The stepwise regressions conducted by Enrollment Category show AFDC as Step 1 in four out of five enrollment categories. The exception is for Enrollment Category 1 (1-200 students). In this regression, Step 1 was the LEP variable, followed by AFDC, then Enrollment. When examining data by Enrollment Category, the ENROLL variable was significant only for the two largest enrollment categories (601-800 students and more than 800 students).

Stepwise regressions conducted by school type shows the variable ENROLL as significant (Step 3) for urban and suburban school types. However, for these same school types, AFDC and LEP were entered as Steps 1 and 2, respectively. Results from the regressions for each of the six AFDC categories show the variable ENROLL as Step 1 for AFDC Category 6 (above 25%), as Step 2 for AFDC Category 5 (21-25%), and as Step 3 for AFDC Category 1(0-5%). School enrollment does not appear as a significant variable in AFDC Categories 2, 3, and 4.

The stepwise regression results are mixed, with the variables AFDC and LEP accounting for most of the explained variance in the model. School enrollment appears as a significant variable in seven of the fifteen stepwise regression equations. The results from the regression analysis and from inspection of the descriptive data in Tables A-1 through A-3 suggest that student characteristics vary among schools in the five size categories, among the three school types, and among schools in the six AFDC categories.

Findings from ANOVA Comparisons

In order to assess the extent of differences in student characteristics and student performance among these data subsets, one-way ANOVA results were examined. First, pairwise contrasts between school types were tested for significant differences in the mean values for the CAP Mean, LEP, and AFDC variables. The results of these contrasts are presented in Table B-2 and indicate that there are significant differences for all pairwise contrasts. Mean student performance is higher in suburban schools as compared to both urban schools and to other non-urban schools. Mean LEP and AFDC percentages are higher in urban settings. These results are consistent with what would be expected given existing information regarding school performance in urban schools as compared to other school types.

Table B-3 displays the results of pairwise contrasts for the variables of CAP Mean, LEP, and ENROLL among AFDC Categories. All contrasts are significantly different when comparing CAP Mean among the six AFDC Categories. There were no significant differences in mean LEP or ENROLL variables between AFDC Categories 3 and 4 and between AFDC Categories 5 and 6 even though there were significant differences in CAP mean between these same contrasts.

Next, pairwise contrasts among the five Enrollment Categories were examined for significant differences in AFDC, LEP, and CAP Mean variables by school type . Results of these comparisons are presented in Table B-4. For the most part, when significant differences in CAP Mean are found, significant differences also exist in the mean values for AFDC and/or LEP. The exception to this general observation is for pairwise contrasts between Enrollment Category 2 (201-400 students) and Enrollment Category 3 (401-600 students). Results for these comparisons indicate significant differences in CAP Mean (favoring Enrollment Category 2) without corresponding differences in AFDC or LEP variables for all schools in the data set and for the subset of suburban schools.

Pairwise contrasts among the five Enrollment Categories were examined for significant differences in LEP and CAP Mean for the six AFDC Categories (Table B-5). Again, significant differences in CAP Mean were generally associated with corresponding differences in mean LEP values. The exception is for AFDC Category 1 where substantial differences in the CAP Mean value exist when comparing Enrollment Categories 1 vs. 2, 1 vs. 3, and 1 vs. 4 with no corresponding significant differences in LEP. In each of these instances, CAP Mean values were lower for Enrollment Category 1 (1-200 students).

The ANOVA analysis between CAP Mean and Enrollment Category also provided a measure of explained variance (η^2). A summary of the variance in CAP mean which is explained by Enrollment Category is depicted in Table B-6. For all schools in the data set, 9% of the variance in CAP Mean is explained by differences in Enrollment Category. The amount of variance in CAP Mean explained by Enrollment Category is greatest for urban schools (16%) and much smaller for suburban schools (4%) and other non-urban schools (2%). When examining this same measure of explained variance by AFDC Category, the amount of variance in CAP Mean explained by Enrollment Category is 6% or less for all AFDC Categories except for Categories 5 and 6 (13% and 17%, respectively). Measures of variance in AFDC and LEP variables which are explained by Enrollment Category are also included in Table B-6.

Findings from the Trend Analysis

As mentioned previously, trend analysis was used to test whether a linear, quadratic, cubic, or some combination of these functions best describes the relationship between the five Enrollment Categories and CAP Mean. Table C-1 displays the results from the trend analysis for all schools in the data set, for the three school types, and for the six AFDC Categories. Trend analysis was also conducted for two additional subsets of data for which there was adequate sample size to conduct the analysis. These two subsets are: 1) all urban schools in AFDC Category 6 (above 25%) and 2) all suburban schools in AFDC Category 1 (0-5%).

Results from the trend analysis indicate that a linear function best represents the relationship between enrollment size and CAP Mean for six of the twelve analyses conducted. Linear functions tested significant for suburban schools, for other non-urban schools, for schools in AFDC Categories 3, 5, and 6, and for urban schools in AFDC Category 6. Both linear and quadratic functions tested significant for three of the trend analyses: all schools, urban schools, and schools in AFDC Category 4. For two of the trend analyses (schools in AFDC Category 1 and suburban schools in AFDC Category 1) the test for trend indicated that a quadratic function only best represented the relationship between CAP Mean and the five enrollment categories. Figures D-1 through D-8 illustrate linear, linear and quadratic, and quadratic results from the trend analyses.

Summary

From the findings in this study, it appears that there are significant differences in student characteristics across enrollment categories, with higher percentages of students in poverty and students who are limited-English speakers in the two largest enrollment categories (more than 600 students) and in the smallest enrollment category (less than 200 students). The analysis also suggests that there are differences in student performance across enrollment categories. When the analysis includes all schools in the data set, the relationship between student performance and the five enrollment categories appears to be linear and quadratic, as illustrated in Figure D-1. A linear and quadratic function is also present when all urban schools are considered as a subset (Figure D-2), while linear functions appear to best represent the relationship for suburban and other non-urban schools (Figures D-3 and D-4).

When examining differences in student characteristics and school type, significant differences appear in the measures of student performance and student characteristics. Not surprisingly, suburban schools demonstrate the better student performance scores and also serve proportionately fewer students in poverty as well as fewer students who are limited-English speakers.

The findings from the regression analyses conducted in this study are consistent with previous research which cites student characteristics as a significant factor related to student performance. Enrollment appears as a significant variable in several of the regressions, but the percent of variance explained by enrollment was relatively low. However, as previously mentioned, regression analysis assumes a linear relationship. Inconclusive results from analyses which attempt to assess the importance of school size in explaining the variance in student performance may be in part attributable to the possibility that a nonlinear relationship best represents the relationship between the variables. Results from the trend analyses support the notion that the relationship between school size and student performance may be both linear and quadratic.

None of the findings from the analyses in this study support the notion that larger schools are associated with improved student performance, even when comparing schools serving students with similar characteristics. In fact, for urban schools serving high percentages of students in poverty, a negative linear relationship was noted between school size and student performance. Additionally, the findings from this study suggest that for schools serving low percentages of students in poverty, student performance may be best at the middle ranges of school size.

This research was designed to be exploratory rather than explanatory in nature. Consequently, no finite conclusions are drawn from the analyses. Rather, the results of this study suggest that the nature of the relationship between school size and student achievement may be different for urban as compared to suburban schools and for schools serving high concentrations of students in poverty as compared to schools serving dramatically smaller percentages of students in poverty.

Recommendations for Future Research

The analyses conducted in this study seem to suggest that additional inquiry regarding the relationship between school size and student achievement is warranted. This study did not address fiscal differences which may be associated with differences in enrollment size categories. This would be a helpful addition to the existing work, especially if the fiscal data was derived from actual expenditures at the school site level instead of using district level estimates. This line of inquiry would also be enhanced by examining teacher characteristics across enrollment size categories. A combination of macroanalytic and microanalytic approaches to the study of school size and its relationship to student achievement would appear to be indicated.

Table A-1

Frequency Distributions for all schools
N=4337

	AFDC Category						
	0-5%	6-10%	11-15%	16-20%	21-25%	26%+	Totals
All Schools	1081	794	679	505	397	882	4337
1-200	133	85	48	45	33	64	408
201-400	291	177	143	107	68	158	944
401-600	454	342	263	192	124	264	1638
601-800	168	146	168	114	109	210	915
801-1000+	35	44	57	47	63	186	432
urban	190	170	194	159	179	544	1436
1-200	12	3	5	1	2	5	28
201-400	57	40	40	31	26	76	270
401-600	81	82	82	63	55	147	510
601-800	34	37	45	41	47	150	354
801-1000+	6	8	22	23	49	166	274
suburban	636	337	260	155	85	101	1574
1-200	29	10	2	3	0	1	45
201-400	172	77	48	20	14	29	360
401-600	302	162	107	75	32	39	717
601-800	[illegible]	72	80	42	31	20	349
801-1000+	24	21	23	15	8	12	103
other non-urban	255	286	225	191	133	237	1327
1-200	92	72	41	41	31	58	335
201-400	62	60	55	56	28	53	314
401-600	71	92	74	54	37	78	406
601-800	25	47	43	31	31	40	217
801-1000+	5	15	12	9	6	8	55

Table A-2

Descriptive Statistics by Enrollment Category and School Type
N=4337

	CAP Mean	%AFDC	%LEP	N
All Schools	287.6	15.9	12.7	4337
1-200	292.3	13.0	5.0	408
201-400	298.4	13.8	8.8	944
401-600	292.9	14.1	10.8	1638
601-800	281.0	17.9	15.7	915
801-1000+	253.3	25.9	29.4	432
urban	267.5	23.7	20.8	1436
1-200	288.3	13.4	13.6	28
201-400	282.8	19.9	14.1	270
401-600	276.3	20.2	16.3	510
601-800	265.4	25.3	20.3	354
801-1000+	236.6	33.1	37.2	274
suburban	305.6	9.5	9.6	1574
1-200	307.6	4.9	1.8	45
201-400	316.2	8.8	7.9	360
401-600	306.7	9.0	8.4	717
601-800	297.7	10.8	12.3	349
801-1000+	286.5	13.1	18.1	103
other non-urban	287.9	15.2	7.7	1327
1-200	290.6	14.1	4.7	335
201-400	291.3	14.5	5.3	314
401-600	289.2	15.5	8.4	406
601-800	279.5	17.5	13.5	217
801-1000+	275.7	14.2	10.9	55

Table A-3

Descriptive Statistics
by AFDC and Enrollment Categories
N=4337

	CAP Mean	%LEP	N
All Schools	287.6	15.9	4337
05%AFDC	324.4	4.6	1081
1-200	303.6	4.4	133
201-400	330.6	4.8	291
401-600	325.9	4.9	454
601-800	327.3	3.7	168
801-1000+	320.1	3.2	35
6-10%AFDC	297.0	8.6	794
1-200	292.7	3.5	85
201-400	300.2	6.9	177
401-600	299.6	8.8	342
601-800	293.2	11.6	146
801-1000+	285.2	13.8	44
11-15%AFDC	285.6	12.8	679
1-200	294.7	7.9	48
201-400	290.7	11.3	143
401-600	284.9	10.9	263
601-800	283.7	15.3	168
801-1000+	274.1	22.3	57
16-20%AFDC	277.8	13.5	505
1-200	283.6	6.5	45
201-400	280.8	10.2	107
401-600	279.6	11.5	192
601-800	279.7	16.2	114
801-1000+	253.9	29.9	47
21-25%AFDC	266.1	20.1	397
1-200	278.8	6.1	33
201-400	279.2	11.2	68
401-600	271.6	15.6	124
601-800	260.5	22.5	109
801-1000+	244.3	41.6	63
26-100%AFDC	250.8	22.54	882
1-200	279.6	4.4	64
201-400	264.2	14.3	158
401-600	255.5	20.7	264
601-800	244.8	24.7	210
801-1000+	229.7	35.9	186

Table A-4

Correlation Matrix for Variables: X_1 ... X_7

	AFDC	LEP	Enroll	Math	Rdg	Write	CAP mean
AFDC	1						
LEP	.343	1					
Enroll	.233	.389	1				
Math	-.52	-.39	-.249	1			
Rdg	-.581	-.49	-.287	.864	1		
Write	-.567	-.479	-.267	.879	.914	1	
CAP mean	-.579	-.472	-.278	.951	.964	.968	1

Note: 1 case deleted with missing values.

Table B-1

Summary of Stepwise Regressions
Y variable=CAP Mean X variables = AFDC, LEP, ENROLL

	N	Step 1 (R^2) (coefficient)	Step 2 (ΔR^2)	Step 3 (ΔR^2)	Total R^2
All schools	4337	AFDC (.335) (-4.08)	LEP (.084) (-2.147)	ENROLL (.003) (-.029)	0.422
0-200	408	LEP (.054) (-.724)	AFDC (.031) (-.534)	NE	0.085
201-400	944	AFDC (.256) (-1.43)	LEP (.047) (-.73)	NE	0.303
401-600	1638	AFDC (.331) (-1.4)	LEP (.073) (-.80)	NE	0.404
601-800	915	AFDC (.407) (-1.52)	LEP (.07) (-.641)	ENROLL (.003) (-.042)	0.480
801-1000+	432	AFDC (.429) (-1.25)	LEP (.14) (-.554)	ENROLL (.006) (-0.012)	0.575
Urban	1436	AFDC (.327) (-1.08)	LEP (.089) (-.523)	ENROLL (.019) (-0.22)	0.435
Suburban	1574	AFDC (.352) (-2.312)	LEP (.046) (-.621)	ENROLL (.005) (-.016)	0.403
Other non-urban	1327	LEP (.17) (-.93)	AFDC (.091) (-.912)	NE	0.261
0-5%AFDC	1081	LEP (.079) (-1.23)	AFDC (.02) (-3.64)	ENROLL (.012)	0.111
6-10%AFDC	794	LEP (.152) (-.903)	AFDC (.018) (-2.98)	NE	0.170
11-15%AFDC	679	LEP (.119) (-.682)	NE	NE	0.119
16-20%AFDC	505	LEP (.118) (.626)	NE	NE	0.118
21-25%AFDC	397	LEP (.208) (-.563)	ENROLL (.019) (-.015)	NE	0.227
26%+AFDC	882	ENROLL (.185) (-.033)	AFDC (.106) (-0.807)	LEP (.029) (-.316)	0.320

NE = Variable not entered in stepwise regression (no forced variables)

Table B-2

Pairwise Contrasts by School Type
Table of Mean Differences for Significant Contrasts*

	CAP Mean	LEP	AFDC	ENROLL
Group 1 v 2	20.4	-13.1	-8.5	-225.8
Group 1 v 3	-17.7	-1.9	5.7	-122.4
Group 2 v 3	-38.1	11.19	14.2	103.4

Group 1 Other Non-Urban Schools
Group 2 Urban Schools
Group 3 Suburban Schools

Table B-3

Pairwise Contrasts by AFDC Category
Table of Mean Differences for Significant Contrasts*

	CAP Mean	LEP	ENROLL
Group 1 v 2	27.5	-4.2	NS
Group 1 v 3	39.8	-8.9	-75.0
Group 1 v 4	47.1	-9.2	-64.0
Group 1 v 5	57.8	-15.8	-156.0
Group 1 v 6	73.1	-18.0	-165.0
Group 2 v 3	12.3	-4.6	-44.0
Group 2 v 4	19.5	-4.9	NS
Group 2 v 5	30.4	-11.6	-125.0
Group 2 v 6	45.6	-13.7	-134.0
Group 3 v 4	7.2	NS	NS
Group 3 v 5	18.1	-7.0	-81.0
Group 3 v 6	33.3	-9.1	-90.0
Group 4 v 5	10.7	-6.6	-91.0
Group 4 v 6	26.0	-8.8	-101.0
Group 5 v 6	15.3	NS	NS

*Scheffe' values used to determine significance (.05 level)

Group 1 0-5% AFDC
Group 2 6-10% AFDC
Group 3 11-15% AFDC
Group 4 16-20% AFDC
Group 5 21-25% AFDC
Group 6 26%+ AFDC

NS= not significant

Table B-4

Pairwise Contrasts for Enrollment Categories by School Type
Table of Mean Differences for Significant Contrasts *

	All Schools N=4337			Urban N=1436			Suburban N=1574			Other Non-Urban N-1327		
	AFDC	LEP	CAP Mean	AFDC	LEP	CAP Mean	AFDC	LEP	CAP Mean	AFDC	LEP	CAP Mean
Group 1 v 2	NS	-3.8	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Group 1 v 3	NS	-5.9	NS	NS	NS	NS	-5.9	-10.5	NS	-3.3	-8.8	11
Group 1 v 4	-4.9	-10.7	11.2	-11.8	NS	NS	NS	NS	NS	NS	NS	NS
Group 1 v 5	-12.9	-24.4	39	-19.6	-23.6	51.7	-8.2	-16.3	NS	NS	-6.2	NS
Group 2 v 3	NS	NS	5.4	NS	NS	NS	NS	NS	9.5	NS	NS	NS
Group 2 v 4	-4.1	-6.9	17.4	-5.3	-8.2	17.4	NS	-4.3	18.5	NS	-8.2	11.8
Group 2 v 5	-12.1	-20.8	45.1	-13.1	-23.2	46.2	-4.3	-10.1	26.7	NS	NS	NS
Group 3 v 4	-3.9	-4.9	11.9	-5	NS	10.9	NS	-3.9	8.9	-5.2	0.15	9.7
Group 3 v 5	-11.9	-18.6	39.7	-12.8	-21	39.8	-4.1	-9.6	20.2	NS	NS	NS
Group 4 v 5	-8	-13.7	27.7	-7.8	-17	28.9	NS	-5.8	NS	NS	NS	NS

Table B-5

Pairwise Contrasts for Enrollment Categories by AFDC Categories
Table of Mean Differences for Significant Contrasts*

	0-5% AFDC		6-10% AFDC		11-15% AFDC		16-20% AFDC		21-25% AFDC		26% AFDC	
	LEP	CAP Mean	LEP	CAP Mean	LEP	CAP Mean	LEP	CAP Mean	LEP	CAP Mean	LEP	CAP Mean
Group 1 v 2	NS	-27.1	NS	NS	NS	NS	NS	NS	NS	NS	-9.8	15.4
Group 1 v 3	NS	-22.4	-5.4	NS	NS	NS	NS	NS	NS	NS	-16.5	24.2
Group 1 v 4	NS	-23.7	-8.2	NS	NS	NS	-9.7	NS	-16.6	NS	-20.2	34.6
Group 1 v 5	NS	NS	-10.3	NS	-14.5	20.6	-23.5	29.7	-35.5	34.5	-31.4	50
Group 2 v 3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-6.5	NS
Group 2 v 4	NS	NS	-4.8	NS	NS	NS	NS	NS	-11.3	18.7	-10.5	19.4
Group 2 v 5	NS	NS	NS	NS	-11	16.6	-19.8	26.9	-30.4	34.9	-21.7	34.6
Group 3 v 4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	10.7
Group 3 v 5	NS	NS	NS	NS	-11.4	NS	-18.5	25.8	-30	27.3	-15.2	25.6
Group 4 v 5	NS	NS	NS	NS	NS	NS	NS	25.8	-19.1	16.2	-11.2	15.2

*Scheffe' values used to test for significance (0.5 Level)
NS= not significant

Enrollment	Categories
Group 1	1-200
Group 2	201-400
Group 3	401-600
Group 4	601-800
Group 5	800+

Table B-6
Summary of Explained Variance (η^2)*

	CAP Mean	LEP	AFDC
All Schools	0.09	0.13	0.06
School Type			
Urban	0.16	0.17	0.08
Suburban	0.04	0.04	0.03
Other Non-Urban	0.02	0.05	0.01
AFDC Category			
0-5%	0.05	0.003	N/A
6-10%	0.02	0.04	N/A
11-15%	0.02	0.05	N/A
16-20%	0.06	0.11	N/A
21-25%	0.13	0.24	N/A
26+%	0.17	0.17	N/A

* η^2 is calculated as the Sum of Squares between Groups divided by the Total Sum of Squares

Table C-1

Summary of Trend Analysis
X=Enrollment Category
Y=CAP mean

Comparison Group	F Ratios*			
	Linear	Quadratic	Cubic	Remainder
All Schools	251.12*	135.51*	0.77	2.04
Urban	57.04*	9.70*	2.8	0.3
Suburban	16.53*	6.59	2.78	1.58
Other Non-Urban	15.09*	2.24	1.21	1.17
0-5% afdc	4.05	16.90*	5.13	7.35
6-10% afdc	3.06	7.94	0.48	0.01
11-15% afdc	13.10*	0.23	0.45	0.92
16-20% afdc	19.48*	9.61*	6.67	1.42
21-25% afdc	40.05*	6.07	0.06	0.06
26%+ afdc	151.94*	0.01	1.95	0
Urban w/26%+ afdc	13.59*	0.002	0.53	0.02
Suburban w/0-5% afdc	1.09	9.13*	8.86*	8.25

* F ratio significant if $F > t^2_{DUNN}$ when $\alpha = .05$; c=3; df > 120

$$t^2_{DUNN} = (2.94)^2 = 8.64$$

Figure D-1

All Schools: Linear and Quadratic

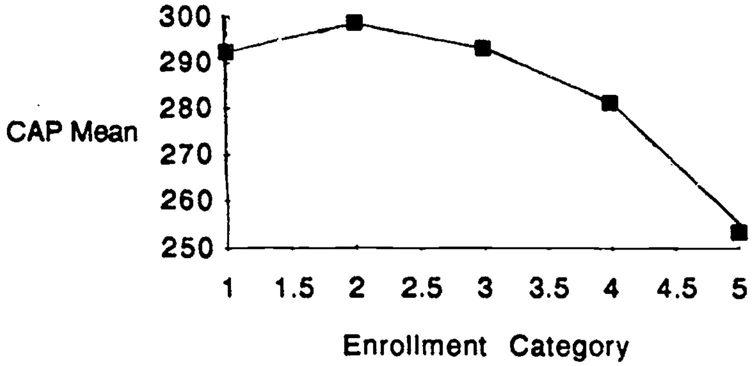


Figure D-2

Urban Schools: Linear and Quadratic

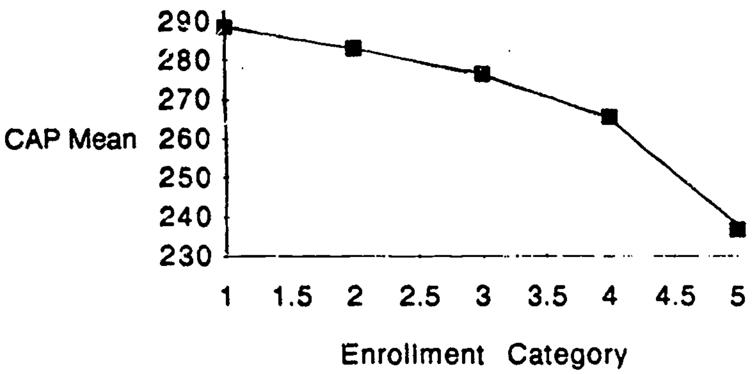


Figure D-3

Suburban Schools: Linear

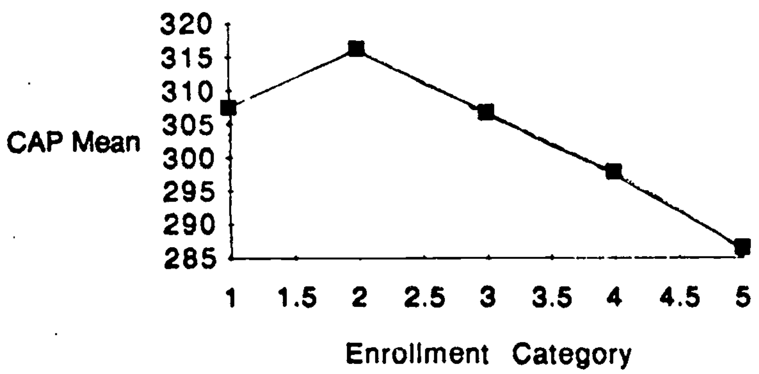


Figure D-4

Other Non-Urban Schools: Linear

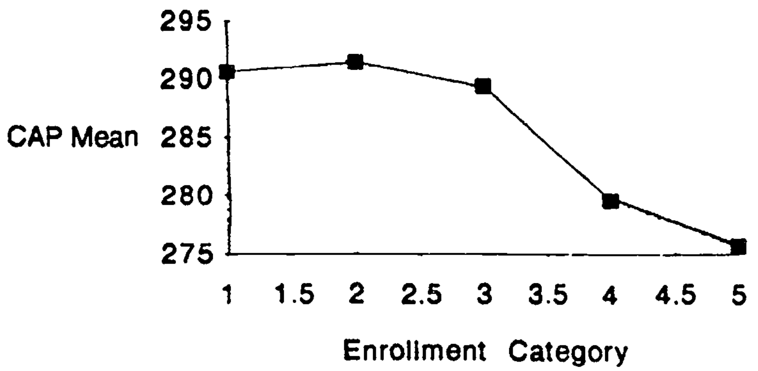


Figure D-5

AFDC Category 1(0-5%): Quadratic

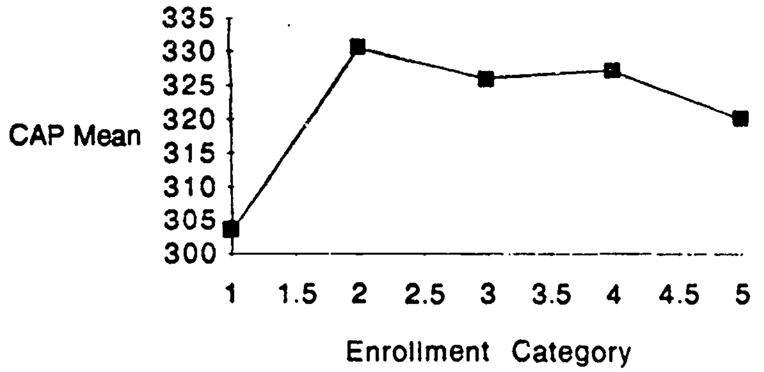


Figure D-6

AFDC Category 6 (26%+): Linear

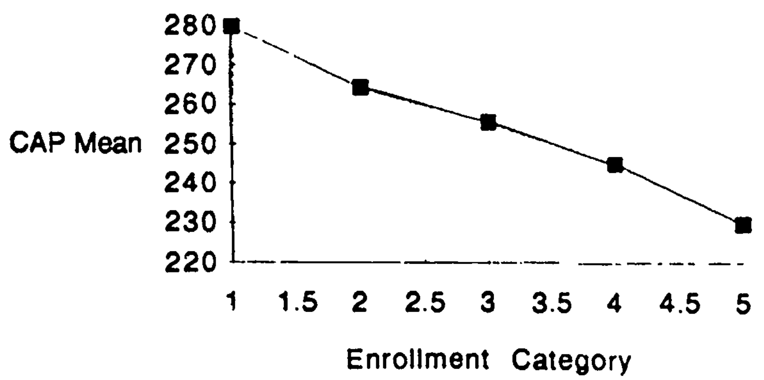


Figure D-7

Urban Schools with AFDC>25%: Linear

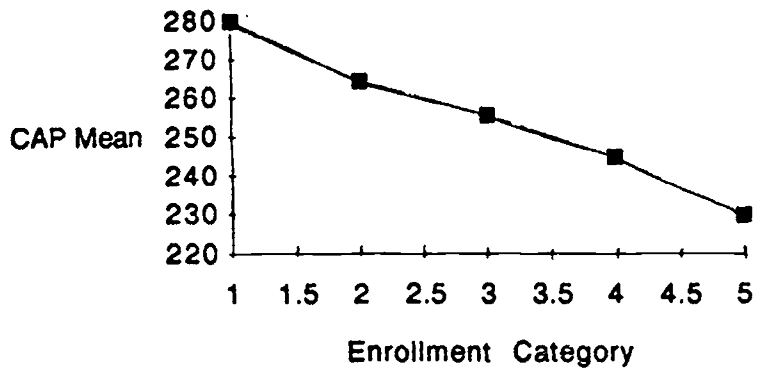
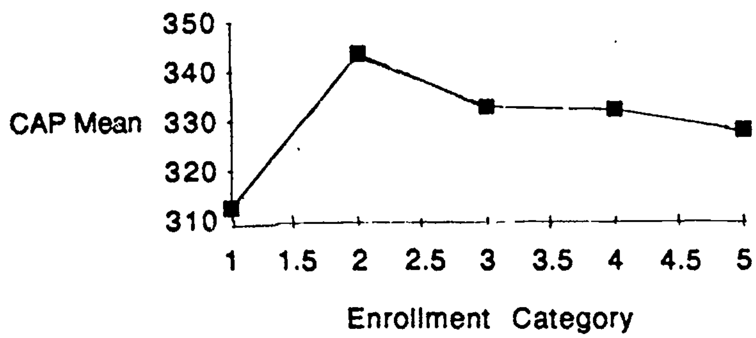


Figure D-8

Suburban Schools with AFDC 0-5%: Quadratic



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