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School Size and the Distribution of Test Scores

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Abstract

After forty years of school consolidation, the preponderance of the evidence, including the results presented in this paper, suggest that the race to reap returns to scale and specialization in education may have come at a high price. This paper uses newly available STAR test score data from California to explore the relationship between school size and the distribution of test scores across elementary, middle, and high schools. We find that school size has a statistically significant and economically large impact on school performance. For example, the probability that an average suburban high school is dominated by low scorers rises from 47% to 71% as the school grows from 200 to 800 students per grade.

Keywords: School Size, Test Scores,
JEL Classifications: Analysis of Education (L20), Education: Government Policy (L28)

1. Introduction

Between 1940 and 1990 the number of public schools in the US declined from approximately 200,000 to 62,037 and the average school size increased from 127 to 653 (Cotton, 1998). Policy makers and school administrators stressed the economies of scale and increased course offerings associated with larger schools. However, after decades of school consolidations and growing public schools, educators have begun to reconsider the efficiency of large schools. The charter school movement and school reform programs in large cities have extolled the benefits of smaller schools.[1]

While there is an extensive literature examining the returns to class size and educational expenditures, only a limited amount of work has focused on the impact of school size. The existing literature has focused primarily on the relationship between school size and per pupil costs. The results generally indicate the existence of economies of scale for schools districts and schools (Riew, 1966; Welch, 1966; Cohn, 1968; Osburn, 1970; Watt, 1980; Kumar, 1983; Bee and Dolton, 1985). However, estimates of cost reduction vary considerably across studies. Likewise, the optimal school sizes estimated by these studies exhaust most of the economies of scale well before reaching the 3,000 to 4,000 student range of many existing high schools.

Increased school size may, however, have adverse effects on school outcomes. Stiefel, et al (1998) find that larger schools in New York City have lower per pupil expenditures but higher per graduate expenditures. Further, recent school shootings have heightened concerns about the lack of individual attention and increased student alienation (Groves, 1999). Research indicates that smaller schools encourage greater student participation in extracurricular and leadership activities, increased student satisfaction, and a greater sense of belonging (Barker and Gump, 1964; Lindsay, 1982; Schoggen and Schoggen, 1988; and Walberg and Walberg, 1994). In addition, smaller schools facilitate greater interaction between students and teachers outside the classroom, as well as encouraging a greater percentage of the students to participate in athletics, student government, clubs and other activities.

In addition to economies of scale, larger schools may also offer students a wider selection of courses, which cater to more homogenous student groups (i.e. streaming), and are taught by teachers with more expertise in a specific subject matter. While the gains to specialized teachers and wider course selection are not particularly contentious[2], the benefits of streaming students by ability are less clear. Proponents of streaming argue that separating students into ability groups allows teachers to target curriculum more effectively. However, not all studies support this positive view of sorting. Betts and Shkolnik (1996) find that ability tracking has little impact on math test score growth. Gamoran and Mare (1989) compare the math test scores of academic and non-academic stream students in the United States and find that streaming reinforces initial differences.[3] Finally, Arnott and Rowse (1987) find that classes with higher ability levels also have higher test score growth rates.

There are also reasons to think that teachers may behave differently in larger schools. A large faculty, like a large firm, is more likely to suffer agency problems. Teachers who are less actively monitored by the administration can spend less time teaching or utilize classroom time in inefficient ways. In short, schools, like other organizations, begin to experience diseconomies of management as they grow. When coupled with the possible negative effects of increasing schools size on student socialization, it is therefore possible that the net benefits of increased school size peak at levels well below current school sizes.

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[1] See Grossman (1999) and Stiefel, et al (1998) for discussion of programs in Chicago and New York.
[2] For example, Betts (1995a) finds that teacher math credentials have a positive impact on math test scores.
[3] In fact, many studies find that ability based streaming widens the gap between streams (Rosenbaum, 1976; Ball, 1981; Oakes, 1985; Arnott and Rowse, 1987).

The results from earlier empirical studies of the relationship between school size and educational outcomes are mixed. Using quantile regressions, Eide and Showalter (1998) find that school size has a positive impact on test scores at all quantiles. In a similar vein, Bedard (1998) finds that high school graduates earn the highest return from medium sized institutions while large schools are beneficial for high school dropouts. Bradley and Taylor (1998) find a quadratic relationship between school size and mean school performance in the UK. Lamdin (1995) and Luyten (1994) find no statistically significant relationship between school size and student outcomes. In contrast, Heck (1993), Deller and Rudnicki (1993), and Fowler and Walberg (1991) find a negative relationship between size and outcomes. Finally, Sander (1993) finds evidence of a positive impact of school size on student outcomes in Chicago.

There are two potential shortcomings in the existing literature. First, estimates of the optimal school size have focused almost exclusively on high schools. The trend toward larger schools, though less pronounced at other levels, is not unique to high schools; both middle and elementary schools have grown substantially. Secondly, previous studies have generally focused on the relationship between school size and average test scores, which may mask the effect of increased school size. Recognizing this point, Brown and Saks (1975) argue that it is only in a multiple output context that the productivity of school inputs can be adequately measured. They show that inputs may impact the variance of test scores without effecting the mean.

To our knowledge, no study has examined the relationship between school size and the distribution of test scores. To a large extent, the absence of research in this area is the result of limited data on school size, test scores and demographic controls at the school level. The California Standardized Testing and Reporting (STAR) exam data fills this void. Beginning in 1998, exam scores are reported by school for grades two through eleven. The STAR exam data includes the average score as well as the proportion of a school's student population that score above the 25th, 50th, and 75th percentiles. This data can be matched to school level characteristics reported by the California Department of Education (CDE).

We expand on Brown and Saks (1975), and the literature exploring the impact of school size, by asking whether or not there is a systematic relationship between school size and the distribution of test scores within schools. While we do not know the entire distribution of scores in each school, we do know the proportion between 0-25, 25-75, and 75-100 percentiles. This information allows us to ask whether school size affects the probability that student outcomes are disproportionately concentrated in a specific part of the distribution. Stated somewhat differently, are student outcomes more likely to be concentrated at the bottom and/or the top of the distribution as schools grow?

The remainder of the paper is as follows. Section 2 describes the STAR test and school data. Section 3 describes our empirical approach. Section 4 presents the results. Section 5 concludes.

2. The STAR Test and California School Level Data

Beginning in 1998, the CDE required all public school students in grades two through eleven to take the Stanford Achievement Test, Ninth Edition, Form T. The exam is part of the state's Standardized Testing and Reporting program and is commonly referred to as the STAR exam. The subjects tested include math, reading, written expression, science (high school only), history and social science (high school only), and spelling (elementary and middle schools only).

The CDE reports the mean score by school, as well as the proportion of students in each school scoring above the 25th, 50th, and 75th nationally normed percentiles.[4]

Rather than report ten sets of results, one for each grade, we focus on grades three, eight, and ten at elementary, middle and high schools respectively.[5] A school is considered an elementary school if it includes kindergarten through grades five or six. A school is included in the middle school category if it includes grades six through seven or eight. All high schools in the sample serve grades nine through twelve. To ensure the comparability of school attributes, schools of all other configurations are excluded. Charter schools, magnet schools, and juvenile detention centers are excluded because of their special nature. Finally, the CDE data excludes schools with fewer than 10 students writing a specific exam for confidentiality reasons.

Following from the discussion in the previous two sections, we designate schools by their largest test score group. The distribution of test scores within schools is broken into three groups: the percentage of students scoring below the 25th percentile, those between the 25th and 75th percentiles and those above the 75th percentile. In order to make the groups comparable, in relative terms, the middle range is divided by two. Each school is then defined as a *good*, *average*, or *poor* school based on its largest relative group. For example, a school with 25% of its students scoring below the 25th percentile, 40% scoring between the 25th and 75th percentiles, and 35% scoring above the 75th percentile would be designated *good*. By contrast a school with the distribution 20%, 60% and 20% would be *average*.

In addition to the STAR test score data, we have information regarding the ethnic breakdown of schools; the percent of each school's population who are Black, Hispanic, Asian,

[4] For more information about the STAR exam see California Department of Education (1998).
[5] Results for other grades, except 11, are similar and available from the authors upon request. Analysis of grade eleven scores is complicated by attrition differences across schools; large urban schools appear to have substantially higher attrition rates after the tenth grade. While the apparently high attrition rates of large schools is an interesting,

Pacific, Filipino, Native American, and White as well as percent of the student body who are limited-English proficient. We also have information on the proportion of students who live in a household receiving AFDC and the proportion eligible for free meals. The CDE also reports the number of computers, whether the school drawing area is urban, suburban, or rural, whether the school operates year-round, the number of teachers, and the number of students. To standardize across schools containing different numbers of grades, school size is defined as the number of students divided by the number of grades[6]. School level descriptive statistics for the mathematics test scores[7] are reported in Table 1.

3. Empirical Approach

We estimate the impact of school size using an ordered probit. The dependent variable is hierarchical: poor, average, and good. Within the framework of a standard ordered probit model, school *s* is a medium school if

$$\frac{k_p - \sum_i b_i X_{si}}{s} < q_s < \frac{k_g - \sum_i b_i X_{si}}{s}$$

where q_s is a standard normal variate, k_p and k_g are the cut points that induce for school designation, and *X* is a vector of socioeconomic and school characteristics.[8] The form of the k's is the crucial issue. Since school size may alter a school's choice set by allowing for new educational options or by changing the return to an existing option, the cut points are a function

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and important issue, the data used in this paper is not ideal for studying this issue because we can not differentiate between school changes and dropouts.

[6] There are three ways to change school size: change the number of grades, change the number of students per grade, or both. Although we define size as students per grade throughout most of the paper, in Table 5 we replicate the analysis using total school size. All results are similar under both size definitions.

[7] The school level summary statistics for the other subject tests are very similar.

[8] As is well known, s is not identified in the ordered probit model described above. We follow standard practice and normalize s to one and then interpret the coefficient estimates as relative to this variance term. This model also produces standardized cut points k_p and k_g which are assumed to be the same for all schools.

of school size. We therefore modify the standard ordered probit model to allow for the possibility that school size may shift the cut points, and that the effect might differ across the two cutoffs.

$$k_p = \bar{k}_p + y_p Size$$

$$k_g = \bar{k}_g + y_g Size$$

This is a relatively straightforward extension of the standard model; however, there is an identification problem. It is not possible to identify all of the parameters if school size is included in *X*, and each cut point is allowed to be an independent function of school size. There are two obvious identification strategies. First, size could be excluded from *X*, so that school size simply shifts the cut points. This is attractive because it allows size to enter cut points with different magnitudes. Alternatively, we could allow size to enter *X* and exclude it from the cut points; this is of course the standard ordered probit model. This, however, restricts school size to have a one-directional impact on test score; it shifts the entire distribution to the left or the right. Since it is possible that size has a differential impact on the probability of being designated 'good' or 'poor,' the flexibility of the first estimation strategy makes it more attractive.

Our estimation strategy can easily be described graphically (see Figure 1). For illustrative purposes consider the two most extreme cases. First, suppose that larger schools enjoy economies of scale, wider course selection, more specialized teachers, and so on, without diseconomies of supervision, loss of individual identity, or congestion (all of the benefits of size with none of the costs). In this environment, we would expect the probability of being designated poor to fall and the probability of being deemed good to rise. In other words, both the poor/average (k_p) and average/good (k_g) cut points should shift to the left with school size (Panel B). At the other extreme, imagine that size has only diseconomies and negative effects on student performance. In this case we would expect both cut points to shift to the right with school size as the probability of being deemed poor rises and the probability of a good school falls. There are, of course, a myriad of possible intermediate outcomes. For example, the top of the distribution could grow as advanced students benefit from a wider range of courses and more specialized instructors while at the same time the bottom grows as weaker students grow disaffected or are increasingly put in classes with other weak students (Panel C).

4. Results

For comparative purposes, Table 2 reports the results from mathematics scores for both the standard ordered probit and the ordered probit that allows the cut points to be a function of size. To ensure that outliers are not driving the results, we exclude elementary schools with more than 250 students, middle schools with more than 700 students and high schools with more than 900 students *per grade*.[9] Several regularities are apparent. Schools with a high proportion of Blacks, Hispanics, or Native Americans are more likely to be poor and less likely to be good. Similarly, schools with a high fraction of students on AFDC, or a high proportion of students eligible for free meals, are also more likely to be designated poor. At the high and middle school levels, a high fraction of limited-English proficient students also makes it more likely that a school is designated poor.

School size is statistically significant in both cut-offs for elementary schools and the lower cut-off for high schools. In contrast, there is no statistically significant relationship between school size and school 'type' at the middle school level. The statistically significant results are most easily described diagrammatically. Figure 2 plots the probability of being

[9] While we have imposed several exclusion restrictions, all results are similar if any/all exclusion restrictions are removed. Table 5 replicates Table 2 including all previously excluded observations.

designated good and poor as school size rises for rural, suburban, and urban schools. This figure highlights two results. First, it indicates that the socioeconomic realities at urban and rural schools make them unlikely to be designated good and very likely to be deemed poor. Secondly, school size has an economically large impact on school performance. An average suburban elementary school with 50 children per grade has a 56% probability of being designated poor and a 26% chance of being designated good compared to the respective 68% and 18% probabilities for a school with 150 students per grade. The impact on high school performance is somewhat different. Increasing school size from 200 to 700 pupils per grade increases the probability of being designated low from 47% to 71% for an average suburban high school, from 74% to 90% for an average rural school, and from 90% to 97% for an average urban school.

To ensure that our results are not peculiar to mathematics, unduly influenced by districts with large, or small, Black, Hispanic, and Native American populations, driven by our exclusion restrictions, or the result of our school size definition, we re-estimate the model for all available subjects using a variety of exclusion restrictions. Table 3 replicates the last three columns of Table 2 for reading, written language, science, social science, and spelling tests. The results are very similar for math, reading, science, and spelling tests for elementary and high schools. Unlike the results for mathematics scores, school size has a significant impact on performance at the middle school level. For all other tests school size is statistically significant in the lower cut-off with a magnitude similar to that of the high school impact.

The other notable difference is that school size is insignificant for the written language and social science tests at the high school level. There are two possible explanations for these insignificant size effects. First, there may be less streaming in these classes. Alternatively english and social science courses may have few course options within the discipline meaning weaker students cannot avoid the more challenging topics. Table 4 replicates the last three columns of Table 2 first excluding schools in which more than 80% of students are Black, Hispanic, or Native American and then excluding those with less than 20%. Again, the results are similar. Finally, Table 5 replicates the last three columns of Table 2 first without data exclusions and then while defining school size as total school size rather than size per grade. In both cases the results are very similar to all previous specifications.

These results indicate that school size has a significant impact on student performance. Larger schools are more likely to be schools with a higher proportion of students performing at low levels on standardized tests. This is consistent across school levels and different subject exams. The primary insight to be gained from these results is that the costs associated with larger schools are quite high.

5. Conclusion

After forty years of school consolidation, the preponderance of the evidence, including the results presented in this paper, suggest that the race to reap returns to scale and specialization in education may have come at a high price. Stiefel et al (1998) show that smaller schools may actually cost less per graduate than larger schools, and this paper has shown that smaller schools are less likely to produce disproportionately bad outcomes. We have further shown that the impact of school size is not only statistically significant, but also economically large. The probability that the average suburban high school is dominated by low scorers rises from 47% to 71% as the school grows from 200 to 800 students per grade.

Beyond the impact on test scores, the social implications may be profound. If the ability, or willingness, of teachers and administrators identify ‘at risk’ students is diminished, minor difficulties are more likely to become major problems. Since this may in turn effect a child's probability of juvenile delinquency, graduation, and post-secondary participation the long-run costs may be even larger than test scores suggest.

Given the current concern about education quality, attempts at reform, and the questionable, and at best limited, ability of increased expenditures or smaller classes to improve educational outcomes and subsequent wages (see Betts (1995b) for a review of the literature), the potential gains from smaller schools should be more fully investigated. More importantly, the cost of reducing school size is generally lower than reducing class sizes. In California, for example, many schools are a series of detached building that could be separated into multiple schools at relatively low cost.

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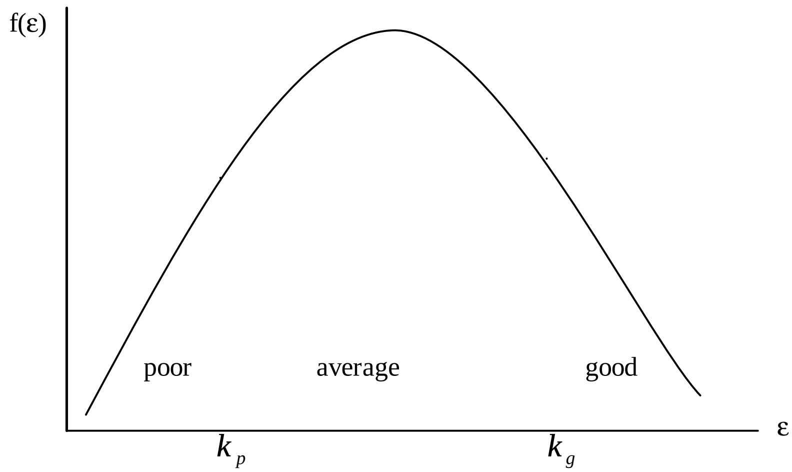
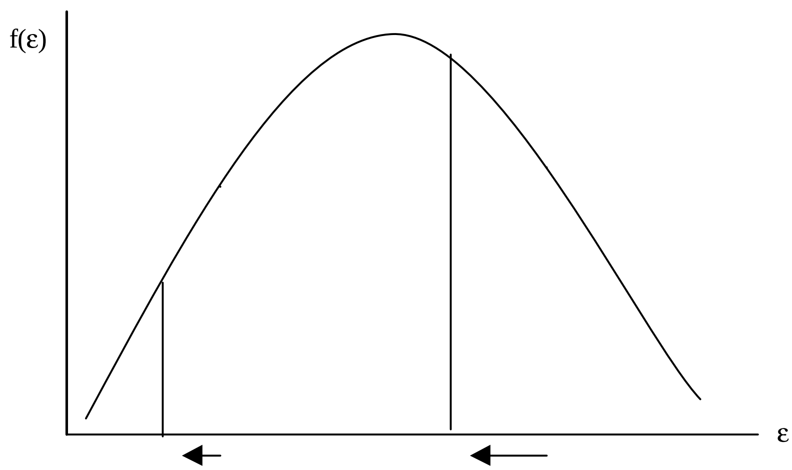
Figure 1

Panel A: Base case



Panel B: Pure Economies of Scale



Panel C: Mixed Economies and Diseconomies of Scale.

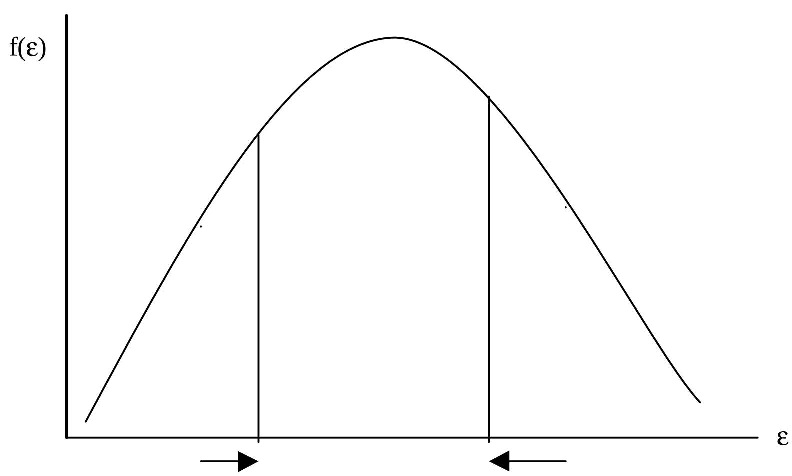
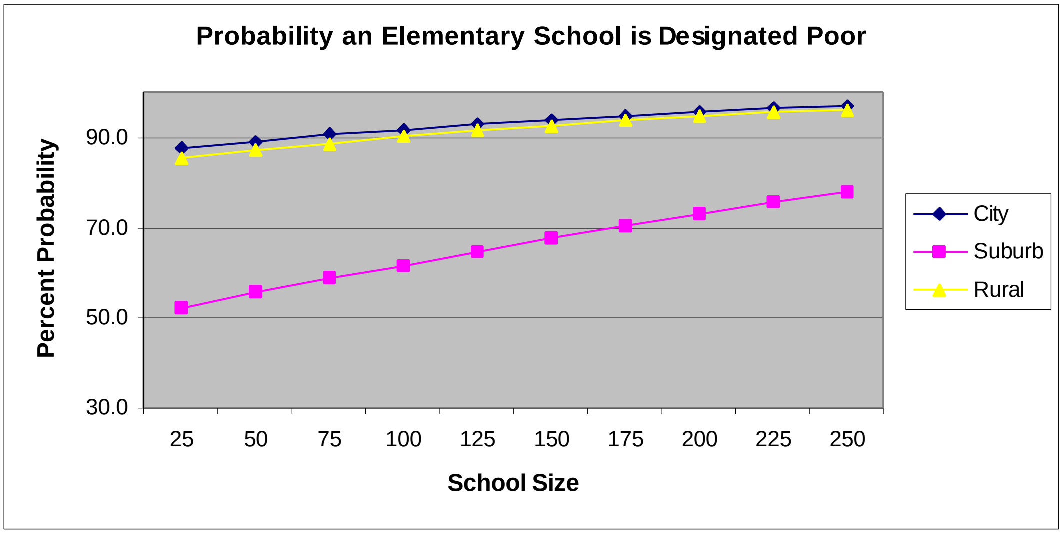
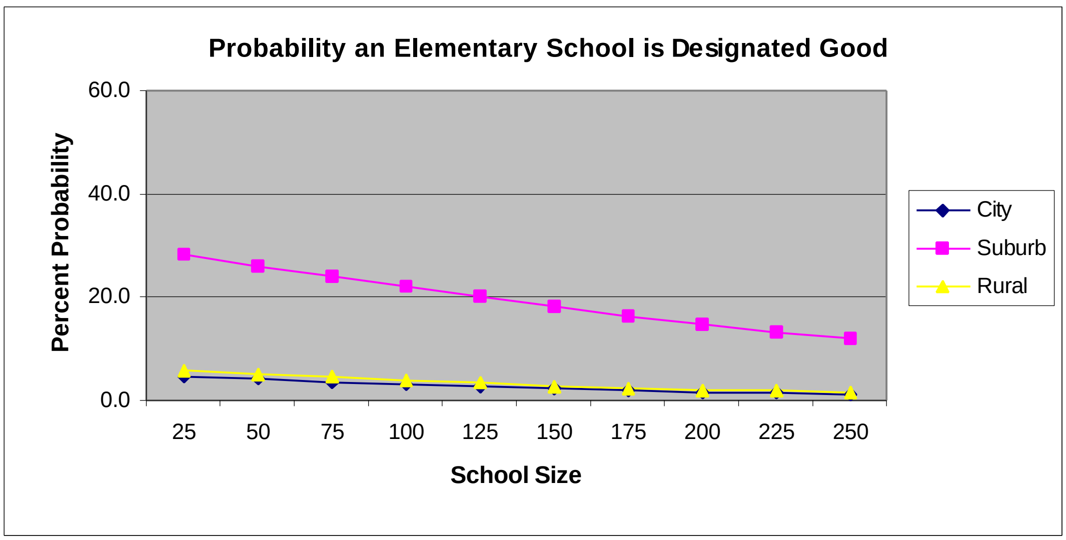


Figure 2


Probability an Elementary School is Designated Poor
Percent Probability
90.0
70.0
50.0
30.0
25
50
75
100
125
150
175
200
225
250
School Size
City
Suburb
Rural


Probability an Elementary School is Designated Good
Percent Probability
60.0
40.0
20.0
0.0
25
50
75
100
125
150
175
200
225
250
School Size
City
Suburb
Rural

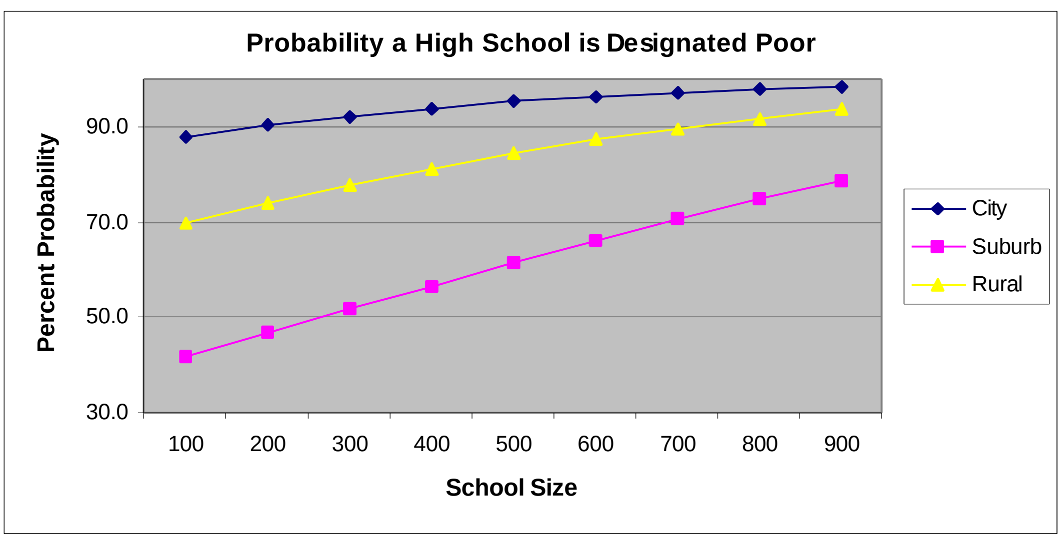

Probability a High School is Designated Poor
Percent Probability
90.0
70.0
50.0
30.0
100
200
300
400
500
600
700
800
900
School Size
City
Suburb
Rural

Table 1. Descriptive Statistics*

	Elementary	Middle	High
Percent of Schools by Type			
Good	21.3	19.2	19.6
Average	8.3	5.7	16.0
Poor	70.5	75.1	64.4
Explanatory Variables			
School Size	102.3496	353.3032	457.9045
	(37.9996)	(134.7945)	(193.1282)
Pupil-Teacher Ratio	21.0263	23.2296	24.0103
	(2.1898)	(2.5711)	(2.9864)
% Black	0.0982	0.0905	0.0751
	(0.1360)	(0.1224)	(0.1181)
% Hispanic	0.4354	0.3809	0.3461
	(0.2825)	(0.2532)	(0.2429)
% Asian	0.0828	0.0938	0.0983
	(0.1185)	(0.1210)	(0.1231)
% Pacific	0.0064	0.0062	0.0061
	(0.0116)	(0.0097)	(0.0091)
% Philipinno	0.0238	0.0243	0.0261
	(0.0497)	(0.0425)	(0.0460)
% Native American	0.0075	0.0088	0.0106
	(0.0165)	(0.0230)	(0.0232)
Computers per Pupil	0.0946	0.1155	0.1157
	(0.0580)	(0.0651)	(0.0647)
% on AFDC	0.2209	0.1722	0.1394
	(0.1704)	(0.1445)	(0.1355)
% Eligible for Free Meals	0.5810	0.4760	0.3086
	(0.2926)	(0.2619)	(0.2167)
% LEP	0.3176	0.2103	0.1508
	(0.2390)	(0.1656)	(0.1240)
Year Round School	0.2566	0.1036	0.0259
	(0.4368)	(0.3050)	(0.1589)
Urban	0.4206	0.3521	0.2961
	(0.4937)	(0.4779)	(0.4569)
Suburban	0.4484	0.4644	0.4531
	(0.4974)	(0.4990)	(0.4982)
Sample Size	2993	801	618

* The descriptive statistics are based on the samples for the mathematics tests, however, the statistics are almost identical under all test subjects. Standard deviations are in parentheses.

Table 2. Ordered Probit Estimates for Mathematics Tests

	Standard Ordered Probit			Ordered Probit with Cut-Offs		
	Elementary	Middle	High	Elementary	Middle	High
School Size	**-0.0030**	-0.0002	-0.0008			
	(0.0011)	(0.0006)	(0.0005)			
Pupil-Teacher Ratio	0.0173	0.0529	-0.0030	0.0175	**0.0512**	-0.0002
	(0.0151)	(0.0298)	(0.0269)	(0.0151)	(0.0298)	(0.0271)
% Black	**-2.1333**	-1.5920	**-2.4318**	**-2.1325**	-1.5998	**-2.4823**
	(0.3647)	(0.9960)	(0.9296)	(0.3644)	(0.9951)	(0.9270)
% Hispanic	**-2.4513**	**-4.0209**	**-2.7303**	**-2.4476**	**-3.9954**	**-2.7699**
	(0.2759)	(0.7937)	(0.5930)	(0.2760)	(0.7928)	(0.5976)
% Asian	0.3733	**2.7829**	**4.3052**	0.3719	**2.7684**	**4.2848**
	(0.3088)	(0.7422)	(0.7479)	(0.3088)	(0.7417)	(0.7556)
% Pacifc	**-8.2864**	-0.9788	-9.5033	**-8.2916**	-0.8494	-9.2812
	(2.5767)	(8.1722)	(8.4769)	(2.5771)	(8.1689)	(8.5013)
% Philipinno	-0.5466	-0.3730	**-2.8089**	-0.5523	-0.4143	**-2.8502**
	(0.5334)	(1.6066)	(1.6417)	(0.5337)	(1.6034)	(1.6521)
% Native	**-6.5995**	0.4589	-4.3957	**-6.6065**	0.4943	-4.5864
	(2.4500)	(3.3114)	(3.8575)	(2.4470)	(3.2244)	(3.9049)
Computers per Pupil	**1.0404**	0.1432	-1.6397	**1.0434**	0.1002	-1.6568
	(0.5151)	(1.1988)	(1.0750)	(0.5150)	(1.1956)	(1.0785)
% on AFDC	**-1.5897**	**-3.3254**	**-3.9102**	**-1.5861**	**-3.2368**	**-3.8674**
	(0.3991)	(1.4507)	(1.0101)	(0.3992)	(1.4508)	(1.0121)
% Eligible for Free Meals	**-1.5823**	**-1.6142**	**-2.0972**	**-1.5846**	**-1.6643**	**-2.1365**
	(0.2972)	(0.8439)	(0.6179)	(0.2973)	(0.8444)	(0.6233)
% LEP	0.2919	**-2.2790**	**-1.9835**	0.2920	**-2.2698**	**-1.9695**
	(0.3403)	(1.2694)	(1.1740)	(0.3405)	(1.2694)	(1.1790)
Year Round School	-0.0357	**-0.8373**	-0.0360	-0.0348	**-0.8333**	-0.0572
	(0.0835)	(0.3030)	(0.4874)	(0.0836)	(0.3037)	(0.4873)
Urban	**0.6201**	-0.3258	-0.0642	**0.6194**	-0.3224	-0.0499
	(0.1152)	(0.2764)	(0.2346)	(0.1152)	(0.2764)	(0.2354)
Suburban	**0.5757**	0.1280	-0.1152	**0.5753**	0.1302	-0.1062
	(0.1026)	(0.2147)	(0.1890)	(0.1026)	(0.2145)	(0.1899)
Lower Cut-Off						
School Size				**0.0032**	0.0005	**0.0012**
				(0.0012)	(0.0006)	(0.0005)
Lower Constant	**-0.9788**	-0.4011	**-2.2339**	**-0.9928**	-0.5399	**-2.4036**
	(0.3308)	(0.7440)	(0.6336)	(0.3318)	(0.7497)	(0.6402)
Upper Cut-Off						
School Size				**0.0027**	-0.0001	0.0001
				(0.0012)	(0.0006)	(0.0005)
Upper Constant	-0.4952	0.0230	**-1.3336**	-0.4647	0.1003	-0.9714
	(0.3304)	(0.7437)	(0.6299)	(0.3352)	(0.7446)	(0.6428)
Sample Size	2993	801	618	2993	801	618
Log-Likelihood	-1464.5	-295.6	-343.7	-1464.3	-294.6	-337.6

Elementary schools with more than 250 students per grade, middle schools with more than 700 students per grade, and high schools with more than 900 students per grade are excluded. Standard errors in parentheses, and bold coefficients are statistically significant at the 10% level or better.

Table 3. Ordered Probit Estimates for Subjects other than Mathematics

	Reading			Language			Sc.	S.S.	Spelling	
	Elem	Middle	High	Elem	Middle	High	High	High	Elem	Middle
PTR	0.0113	0.0013	-0.0114	**0.0350**	0.0090	0.0216	-0.0084	0.0124	0.0019	-0.0228
	(0.0165)	(0.0273)	(0.0358)	(0.0154)	(0.0280)	(0.0312)	(0.0258)	(0.0255)	(0.0152)	(0.0304)
% Black	**-1.6421**	**-2.7024**	**-2.2346**	**-1.3354**	**-2.3202**	**-1.7829**	**-2.6571**	**-1.6817**	-0.3665	-1.0046
	(0.3639)	(0.8863)	(1.1875)	(0.3308)	(0.8771)	(0.9625)	(0.9246)	(0.7728)	(0.3060)	(0.9299)
% Hispanic	**-2.8331**	**-3.4189**	**-6.1142**	**-2.7260**	**-2.9918**	**-3.4663**	**-2.3689**	**-2.3486**	**-2.0234**	**-3.3321**
	(0.3193)	(0.6650)	(1.3091)	(0.2860)	(0.6593)	(0.7033)	(0.5107)	(0.4793)	(0.2954)	(0.8515)
% Asian	**-0.8411**	-0.4791	1.0862	-0.4376	-0.3447	**1.4932**	**1.2045**	0.4693	**1.4169**	0.5598
	(0.3443)	(0.5953)	(0.7671)	(0.3222)	(0.5929)	(0.6548)	(0.5892)	(0.5645)	(0.3271)	(0.6401)
% Pacifc	-2.8516	5.6542	**-57.4517**	**-6.4129**	-2.8127	-11.1580	**-29.8324**	-8.2083	**-4.6357**	2.9396
	(2.6914)	(6.8588)	(19.8003)	(2.5250)	(7.1698)	(10.6706)	(10.6407)	(7.6359)	(2.4438)	(7.6282)
% Philipinno	**-1.1786**	-0.6535	1.4253	-0.7110	-0.6705	**-5.6192**	**-3.3535**	-0.9708	**1.6266**	1.8666
	(0.5426)	(1.3474)	(2.5224)	(0.5331)	(1.4551)	(2.5323)	(2.0231)	(1.4380)	(0.5368)	(1.5582)
% Native	-2.1040	-1.6703	**-11.3256**	**-4.1151**	-0.2983	-5.6444	-0.8131	0.4628	-2.9208	-3.7133
	(2.2018)	(3.3565)	(4.6095)	(2.2150)	(2.7058)	(3.9985)	(2.9195)	(2.7615)	(2.4337)	(4.7899)
Comp/Pupil	0.5483	1.4910	0.1386	0.6275	-0.4515	-0.6454	0.1538	-0.1834	**1.0397**	-0.2986
	(0.5594)	(1.0520)	(1.4574)	(0.5308)	(1.0709)	(1.1939)	(1.0201)	(1.0183)	(0.5127)	(1.1645)
% on AFDC	**-1.8867**	**-2.6254**	0.4174	**-1.3745**	**-4.2627**	-0.9530	-0.9790	**-1.3332**	**-1.3196**	**-4.3814**
	(0.4711)	(1.2093)	(1.0238)	(0.4029)	(1.3222)	(0.7864)	(0.7322)	(0.6892)	(0.4047)	(1.7571)
% Free Meals	**-2.4841**	-0.9885	**-4.3708**	**-2.2872**	-0.5775	**-2.0276**	**-1.8885**	**-0.9524**	**-2.2129**	-0.6571
	(0.3296)	(0.7270)	(0.9629)	(0.2950)	(0.7601)	(0.6225)	(0.5234)	(0.4883)	(0.2963)	(0.8961)
% LEP	-0.2581	**-2.8063**	**-5.8291**	0.1055	**-1.9970**	-1.2594	**-3.0125**	-1.4028	-0.4177	**-3.7379**
	(0.4126)	(1.1096)	(2.3922)	(0.3571)	(1.0861)	(1.3669)	(1.0766)	(0.9621)	(0.3856)	(1.4449)
Yr Rnd Sch	-0.1124	**-0.5306**	0.3165	-0.1129	**-0.6750**	0.0008	0.0564	-0.2292	-0.0260	**-0.5538**
	(0.0940)	(0.2484)	(0.4663)	(0.0874)	(0.2706)	(0.4461)	(0.4050)	(0.3967)	(0.0863)	(0.3236)
Urban	**0.2982**	0.3445	0.1933	**0.4265**	0.3413	-0.1205	-0.0594	0.1311	**0.4916**	**0.6264**
	(0.1214)	(0.2443)	(0.3141)	(0.1134)	(0.2505)	(0.2510)	(0.2128)	(0.2122)	(0.1191)	(0.2964)
Suburban	**0.1883**	0.3005	0.2174	**0.3565**	0.2796	0.1130	-0.0290	0.0485	**0.4026**	**0.6337**
	(0.1060)	(0.1982)	(0.2518)	(0.0997)	(0.2045)	(0.2015)	(0.1711)	(0.1730)	(0.1051)	(0.2444)
Lower Cut-Off										
School Size	**0.0052**	**0.0013**	**0.0015**	**0.0041**	**0.0015**	0.0004	**0.0009**	0.0005	**0.0035**	**0.0016**
	(0.0014)	(0.0006)	(0.0007)	(0.0012)	(0.0006)	(0.0005)	(0.0005)	(0.0004)	(0.0012)	(0.0006)
Lower Cons	**-2.3105**	**-1.7283**	**-2.7470**	**-1.4236**	**-1.6675**	-0.8655	**-2.2679**	-0.9114	**-1.2154**	**-1.6718**
	(0.3680)	(0.7050)	(0.8775)	(0.3403)	(0.7110)	(0.7127)	(0.6188)	(0.5975)	(0.3369)	(0.7777)
Upper Cut-Off										
School Size	**0.0047**	0.0001	0.0004	**0.0023**	0.0005	-0.0002	0.0003	0.0006	0.0010	-0.0001
	(0.0014)	(0.0006)	(0.0007)	(0.0013)	(0.0006)	(0.0006)	(0.0005)	(0.0005)	(0.0014)	(0.0007)
Upper Cons	**-1.5858**	-0.7243	**-1.4679**	**-0.6622**	**-1.1594**	0.1233	**-1.0450**	-0.5255	-0.0931	-0.6838
	(0.3717)	(0.7035)	(0.8798)	(0.3425)	(0.7067)	(0.7240)	(0.6145)	(0.6012)	(0.3415)	(0.7754)
Sample Size	2959	800	598	2970	805	606	621	623	2992	803
Log-Likelihood	-1219.0	-359.0	-212.7	-1377.2	-321.6	-309.6	-377.4	-415.7	-1419.4	-284.1

Elementary schools with more than 250 students per grade, middle schools with more than 700 students per grade, and high schools with more than 900 students per grade are excluded. Standard errors in parentheses, and bold coefficients are statistically significant at the 10% level or better.

Table 4. Ordered Probit Estimates for Mathematics Excluding Schools with Large and Small Percentages of Blacks, Hispanics, and Natives

	Excluding Schools with >80% Blacks, Hispanics & Natives			Excluding Schools with <20% Blacks, Hispanics & Natives		
	Elementary	**Middle**	**High**	**Elementary**	**Middle**	**High**
Pupil-Teacher Ratio	0.0249	**0.0516**	0.0012	0.0227	**0.0976**	0.0029
	(0.0161)	(0.0299)	(0.0271)	(0.0170)	(0.0402)	(0.0330)
% Black	**-2.4502**	-1.5225	**-1.9397**	**-1.7865**	-1.3527	**-2.3014**
	(0.4504)	(1.0328)	(1.1141)	(0.3861)	(1.0854)	(0.9979)
% Hispanic	**-2.6871**	**-3.9899**	**-2.7335**	**-2.0400**	**-3.7488**	**-2.6966**
	(0.2977)	(0.7970)	(0.6114)	(0.3191)	(0.9518)	(0.7397)
% Asian	**0.6401**	**2.7707**	**4.2805**	**0.7407**	**2.8513**	**4.2454**
	(0.3260)	(0.7426)	(0.7569)	(0.3816)	(0.9829)	(0.9239)
% Pacifc	**-7.4565**	-0.8364	-10.1572	**-7.2521**	-16.3560	-14.6189
	(2.6516)	(8.1679)	(8.5750)	(2.6574)	(13.0468)	(9.6214)
% Philipinno	-0.5291	-0.4360	**-3.0183**	-0.3910	0.4406	-1.9197
	(0.5457)	(1.6042)	(1.6682)	(0.6179)	(2.0843)	(1.9020)
% Native	**-5.9595**	1.0016	-4.4914	-3.4974	1.4811	-4.1532
	(2.4547)	(3.9378)	(3.9106)	(2.8009)	(2.6440)	(5.4565)
Computers per Pupil	**1.1050**	0.0792	-0.4173	0.7925	-0.3842	-0.2661
	(0.5370)	(1.1992)	(0.2702)	(0.5993)	(1.4283)	(0.3352)
% on AFDC	**-1.8018**	**-3.2585**	**-3.9268**	**-1.6888**	**-3.4847**	**-2.9016**
	(0.4502)	(1.4547)	(1.0169)	(0.4179)	(1.5762)	(1.0389)
% Eligible for Free Meals	**-1.4610**	**-1.6711**	**-2.2044**	**-1.2096**	-0.4631	**-1.8384**
	(0.3240)	(0.8459)	(0.6308)	(0.3234)	(1.0005)	(0.6639)
% LEP	-0.0266	**-0.8342**	-0.0496	0.0112	**-0.9821**	0.0462
	(0.0891)	(0.3038)	(0.4868)	(0.0925)	(0.4768)	(0.5811)
Year Round School	0.0703	**-2.2523**	-1.9168	0.0797	-1.6507	**-2.4464**
	(0.3770)	(1.2719)	(1.1912)	(0.3588)	(1.3272)	(1.2577)
Urban	**0.5788**	-0.3214	-0.0715	**0.6766**	-0.3210	-0.2590
	(0.1201)	(0.2779)	(0.2366)	(0.1385)	(0.3525)	(0.2727)
Suburban	**0.5694**	0.1329	-0.1127	**0.6277**	-0.0444	-0.3005
	(0.1054)	(0.2163)	(0.1903)	(0.1299)	(0.2807)	(0.2379)
Lower Cut-Off						
School Size	**0.0027**	0.0005	**0.0013**	**0.0040**	0.0007	**0.0010**
	(0.0013)	(0.0006)	(0.0005)	(0.0013)	(0.0008)	(0.0006)
Lower Constant	**-0.8475**	-0.5248	**-2.3974**	-0.4939	0.8713	**-2.1469**
	(0.3525)	(0.7517)	(0.6409)	(0.3876)	(0.9912)	(0.7829)
Upper Cut-Off						
School Size	**0.0023**	-0.0001	0.0001	**0.0040**	-0.0002	0.0000
	(0.0013)	(0.0006)	(0.0005)	(0.0015)	(0.0009)	(0.0007)
Upper Constant	-0.3379	0.1164	-0.9597	-0.0418	1.5482	-0.7200
	(0.3553)	(0.7468)	(0.6434)	(0.3943)	(0.9997)	(0.7970)
Sample Size	2257	679	548	2490	637	463
Log-Likelihood	-1351.4	-294.5	-337.0	-1119.5	-178.2	-212.0

Elementary schools with more than 250 students per grade, middle schools with more than 700 students per grade, and high schools with more than 900 students per grade are excluded. Standard errors in parentheses, and bold coefficients are statistically significant at the 10% level or better.

Table 5. Ordered Probit Estimates for Mathematics with No Data Exclusions and Defining School Size as Total School Size rather than Size per Grade

	No Data Exclusions			Total School Size		
	Elementary	Middle	High	Elementary	Middle	High
Pupil-Teacher Ratio	0.0163	**0.0565**	-0.0030	0.0189	0.0464	-0.0002
	(0.0150)	(0.0295)	(0.0266)	(0.0153)	(0.0299)	(0.0271)
% Black	**-2.1529**	**-1.7218**	**-2.5230**	**-2.1481**	-1.5850	**-2.4823**
	(0.3650)	(0.9891)	(0.9270)	(0.3642)	(1.0013)	(0.9270)
% Hispanic	**-2.4666**	**-4.0996**	**-2.8241**	**-2.4502**	**-3.9990**	**-2.7699**
	(0.2755)	(0.7891)	(0.5860)	(0.2760)	(0.7948)	(0.5976)
% Asian	0.3566	**2.7060**	**4.2782**	0.3708	**2.7725**	**4.2848**
	(0.3080)	(0.7390)	(0.7424)	(0.3090)	(0.7427)	(0.7556)
% Pacifc	**-8.2400**	-0.2363	-6.8795	**-8.3002**	-0.2688	-9.2812
	(2.5729)	(8.1390)	(8.1891)	(2.5760)	(8.2131)	(8.5013)
% Philipinno	-0.5860	-0.6025	-2.3074	-0.5494	-0.6081	**-2.8502**
	(0.5333)	(1.5983)	(1.5828)	(0.5341)	(1.6082)	(1.6521)
% Native	**-6.5519**	0.8375	-5.2150	**-6.6183**	0.6053	-4.5864
	(2.4494)	(3.1479)	(3.8593)	(2.4447)	(3.1502)	(3.9049)
Computers per Pupil	**1.0659**	0.4001	-1.3332	**1.0328**	0.1570	-1.6568
	(0.5143)	(1.1763)	(1.0502)	(0.5158)	(1.2013)	(1.0785)
% on AFDC	**-1.6242**	**-3.1301**	**-2.9630**	**-1.5559**	**-3.2387**	**-3.8674**
	(0.3983)	(1.4293)	(0.8935)	(0.3995)	(1.4432)	(1.0121)
% Eligible for Free Meals	**-1.5579**	**-1.7048**	**-2.3192**	**-1.5831**	**-1.6798**	**-2.1365**
	(0.2967)	(0.8382)	(0.6015)	(0.2972)	(0.8413)	(0.6233)
% LEP	0.3181	**-2.1419**	**-1.9687**	0.2731	**-2.2613**	**-1.9695**
	(0.3387)	(1.2598)	(1.1446)	(0.3398)	(1.2713)	(1.1790)
Year Round School	-0.0368	**-0.8479**	-0.1313	-0.0322	**-0.8268**	-0.0572
	(0.0832)	(0.3019)	(0.4881)	(0.0844)	(0.3036)	(0.4873)
Urban	**0.6211**	-0.2760	-0.1038	**0.6165**	-0.3796	-0.0499
	(0.1149)	(0.2720)	(0.2308)	(0.1150)	(0.2786)	(0.2354)
Suburban	**0.5730**	0.1159	-0.1872	**0.5761**	0.0979	-0.1062
	(0.1024)	(0.2126)	(0.1869)	(0.1026)	(0.2143)	(0.1899)
Lower Cut-Off						
School Size	**0.0026**	0.0002	**0.0008**	**0.0005**	0.0002	**0.0003**
	(0.0011)	(0.0006)	(0.0005)	(0.0002)	(0.0003)	(0.0001)
Lower Constant	**-0.9596**	-0.3208	**-2.2739**	**-0.9651**	-0.6668	**-2.4036**
	(0.3310)	(0.7353)	(0.6288)	(0.3315)	(0.7538)	(0.6402)
Upper Cut-Off						
School Size	**0.0024**	-0.0006	-0.0003	**0.0004**	-0.0005	0.0000
	(0.0012)	(0.0006)	(0.0005)	(0.0002)	(0.0003)	(0.0001)
Upper Constant	-0.4607	0.3904	-0.8628	-0.4277	0.2998	-0.9714
	(0.3342)	(0.7279)	(0.6311)	(0.3351)	(0.7481)	(0.6428)
Sample Size	3021	834	638	2993	801	618
Log-Likelihood	-1470.6	-299.5	-348.3	-1464.6	-291.8	-337.6

Elementary schools with more than 250 students per grade, middle schools with more than 700 students per grade, and high schools with more than 900 students per grade are excluded in last three columns. Standard errors in parentheses, and bold coefficients are statistically significant at the 10% level or better.