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ABSTRACT

Some previous research has found that smaller schools perform at higher levels than larger schools and reduce the negative effects of poverty on school performance. This paper analyzes the effects of school size on four measures of school performance in elementary schools in Fayette County, Kentucky; elementary schools in Fayette and Jefferson Counties (the two largest school districts in the state); and all schools in the two county districts. Multivariate models for elementary schools in the two districts find that size and size interacting with poverty have no effect on school performance; instead, poverty is the major determinant of performance. Looking at all schools in the two districts again finds that smaller school size does not reduce the negative effects of poverty on performance. Instead, poverty remains a substantial determinant of performance; performance varies significantly by school type (elementary, middle, or high school); and the interaction of poverty with elementary schools is significant for several measures of performance. The findings suggest that if policymakers wish to improve the performance of urban/suburban schools, focusing on school size does not appear to offer answers. Disputes over school mergers or consolidations may be costly diversions from the more important issues of disadvantage and equal opportunity in education. Policymakers in urban/suburban districts with many schools and diverse neighborhoods should consider drawing attendance boundaries to distribute poor children more equitably across schools, regardless of school size. (Contains 12 references.) (SV)

RESISTING THE URGE TO MERGE: DOES SCHOOL SIZE MATTER?

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RESISTING THE URGE TO MERGE: DOES SCHOOL SIZE MATTER?

SUMMARY

Some previous research finds that smaller schools perform at higher levels than larger schools and smaller schools reduce the negative effects of poverty on school performance. This analysis of the effects of size on four measures of school performance begins with one school district in Kentucky (Fayette) that is considering the merger of several small elementary schools, then expands to elementary schools in the two largest districts in the state (Jefferson and Fayette), and then to all schools in these two districts using a more complex model of school performance. Multivariate models for elementary schools in these two districts find that size and size interacting with poverty have no effect on school performance; instead, poverty is the major determinant of performance. This initial finding suggests that school type (elementary, middle, or high school) may be a more important predictor of school performance than size or the interaction of size and poverty. Testing for interaction effects of poverty with both size and school type for all schools in these two districts again finds that smaller school size does not reduce the negative effects of poverty on performance. Instead, poverty remains a substantial determinant of performance, performance continues to vary significantly by school type, and the interaction of poverty with elementary schools is significant for several measures of performance.

Given the many conflicting goals, values, and interests involved in education policy research, the implications of these findings on school size and performance are neither simple nor indisputable. Some education experts argue that merging smaller schools will lower costs, usually believed to be the result of increased economies of scale. Conversely, other experts advocate keeping smaller schools due to their presumably more effective school cultures, often the result of strong community or neighborhood involvement. This research suggests that if an important question for education policy makers is how to improve the performance of schools in urban/suburban districts, focusing on school size does not appear to offer answers. Not only do smaller schools in these samples not demonstrate superior performance or moderate the negative impact of disadvantage on school performance in these samples, but larger schools also do not demonstrate superior performance if these larger schools have high proportions of disadvantaged children. Since school performance is so strongly and negatively related to disadvantage and since school size does not affect school performance, neither keeping smaller schools with large proportions of disadvantaged students nor creating larger schools with large proportions of disadvantaged students is likely to improve school performance. This analysis suggests that disputes over school mergers or consolidations may be costly diversions from the more important issues of disadvantage and equal opportunity in education. Policy makers in urban/suburban districts with many schools and diverse neighborhoods should consider drawing attendance boundaries to distribute poor children more equitably across schools, regardless of school size.

RESISTING THE URGE TO MERGE: DOES SCHOOL SIZE MATTER?

As with many states and school districts throughout the nation, public school systems in Kentucky continue to confront the contentious issue of school closings and consolidations. For example, a recent newspaper article describes preliminary plans proposed by two Fayette County School District committees to close and merge several elementary schools and explores the complex issues of school size, performance, race, and poverty that permeate and complicate these types of merger proposals (Defendall, 2002). Groups of African-Americans and supporters of a small elementary school are critical of a plan to close the school and merge it with another elementary school just several blocks away, even with a proposal to spend $4.7 million to renovate the newly merged school. Parents of children in the school to be closed argue that improving test scores are the direct result of the school's "small size and focus on the individual learning style of each child." The article then states that national studies demonstrate that low-income and minority children are more likely to succeed in small schools and smaller schools have higher student achievement, better attendance, lower dropout/failure rates, and fewer discipline problems. The news article does provide a note of caution about these findings or assertions by quoting UK Education Professor Alan DeYoung that there is no magic number for school size, and research does not demonstrate that a school of 200 would necessarily be more successful than a school of 400.

Size is a popular explanatory variable for many types of human activities including industrial manufacturing, computing, military weaponry, basketball, and schooling. Although in many of these endeavors bigger is alleged to be better as evidenced by the continuing waves of mergers and acquisitions in the corporate world, there are important exceptions such as electronics, the quick little point guard, and perhaps public schooling. In a comprehensive review of research on the effects of size on schooling, Cotton (May, 1996: 5-6) concludes that since half the research studies on student achievement find no differences between large and small schools, and the other half find superior achievement in small schools, "we may safely say that student achievement in small schools is at least equal – and often – superior – to student achievement in large schools." Addressing the assertion that low-income and minority children are more likely to succeed in small schools, Cotton also concludes that previous research finds "large schools have a more negative impact on minority and low-SES students than on students in general."

Another review of research on school size by Irmsher (1997) finds that larger schools do not produce greater academic success at lower costs. In contrast to the supposed advantages of economies of scale or cost-savings that apparently have not occurred with school consolidation, she cites research that finds more teacher innovation and student participation, greater satisfaction, higher grades and test scores, and improved attendance and lower dropout rates in smaller schools. Although many factors may relate to these differences, the explanation she prefers equates size with type of organization - large schools are bureaucracies with all the presumed pathologies of impersonality and complexity, while small schools are communities with all the presumed benefits of simplicity and intimacy. Irmsher does qualify these conclusions by stating that previous research finds that size alone does not guarantee success and there is little or no agreement on optimal school size. A later review of research on school size by McRobbie (October, 2001) echoes many of the conclusions of Irmsher and Cotton, but adds the issue of school violence which she finds is "less likely in smaller schools." The report concludes that "while impersonal bigness may actually

provoke disruptive or violent behavior, small schools conducive to trust and respect tend to defuse it."

As suggested by Cotton's review of research on the effects of school size, race and poverty often complicate the size-performance relationship. Darling-Hammond (1998) focuses on race and contends that lower educational outcomes for minority children are due more to unequal access to key educational resources such as skilled teachers and quality curriculum than to race. She concludes that thirty years of research shows that four factors consistently affect student achievement – smaller school size (300-500 students), smaller class size (especially for elementary schools), challenging curriculum, and more highly qualified teachers all relate to higher student performance; and most importantly for the issue of equality - minority students are much less likely than white students to have these resources.

In some contrast to these findings about the importance of school size on performance, I find in previous research on Kentucky's school reform program (KERA) that not only is poverty the most consistent, significant, and substantial predictor of school and district performance, but school size appears to be less useful in explaining school performance than type of school (Roeder, February 2000 and June 2000). The models estimated in these previous papers include both school size (enrollment) and dummy variables for type of school (elementary, middle, or high school), and in almost all the models size is not significant when dummy variables for school type are included in the equations. More importantly, poverty is the strongest predictor of performance on Kentucky's accountability index controlling for size as well as several other school characteristics.

An alternative to considering the direct effects of both type of school and size of school in modeling school performance is provided by Craig Howley and his associates. These researchers test an interaction hypothesis that the "strength and directionality of the relationship of size to achievement is linked to (or contingent on) community socioeconomic status" (Johnson, Howley, and Howley, February 2002) Much empirical research on issues of school size and performance by Howley and his associates has been supported by The Rural School and Community Trust. For example, a February 2000 report issued by the Trust examines the impact of poverty and size on performance in about 13,600 schools in 2,290 districts in four states – Georgia, Montana, Ohio, and Texas and finds that in Georgia, Ohio, and Texas "students in the less affluent communities in each state perform better when they attend smaller schools (Howley and Bickel, 2000). The researchers call this the "excellence effect" of small schools and conclude that "as schools become larger, the negative effect of poverty on student achievement increases." Later research with schools in Arkansas using the same concepts and models reinforces the earlier findings and provides additional results and policy recommendations (Johnson, Howley, and Howley, February 2002).

SIZE AND PERFORMANCE IN FAYETTE COUNTY ELEMENTARY SCHOOLS

This exploration of relationships among school size, poverty, race, and performance begins with data from Fayette County elementary schools in 2000. Appendix A lists these schools in order by size from Russell (one of the schools that may be merged) with an enrollment of 203 to Stonewall with 693. Table 1 shows that the average enrollment of 34 Fayette elementary schools is 466 with a minority population of almost 31 percent and a poverty population of almost 50 percent. To provide some perspective, these averages compare to the largest district in Kentucky - Jefferson County, about 2 ½ times the size of Fayette County, where 88 elementary schools have an average enrollment of 540, a minority population of 35 percent, and a poverty population of 61 percent. Despite these similarities, Jefferson County in 2000 had only one elementary school with fewer

than 300 students and only 6 with fewer than 400 students compared to Fayette County where almost half the elementary schools had fewer than 400 students.

To further highlight possible interrelationships among race, poverty, size, and performance, not only are Jefferson County elementary schools on average somewhat larger with proportionately more poor and minority students than Fayette, but they perform at lower levels as indicated by the CATS index score of 62.5 (Fayette is 68.8) and the CTBS/5 score of 46 (Fayette is 56.2). Jefferson County elementary schools will be combined with Fayette County elementary schools in a more extensive analysis below.

TABLE 1
FAYETTE COUNTY ELEMENTARY SCHOOLS DATA SUMMARY (2000)

Variable	# Obs	Mean	Std Dev	Skew	Min	Max
Enroll	34	466	154	-.16	203	693
% minority	32	30.8	18.8	.77	5.3	72.4
% poverty	34	49.8	29.1	.20	6.0	99.0
CTBS/5	34	56.2	17.2	.16	25.0	85.0
CATS	34	68.8	14.0	.37	48.6	96.1
Attendance	34	95.0	.87	-.27	92.6	97.0

For the dependent variables used in this study and summarized in the bottom three rows of Table 1, relationships among the measures of school performance are relatively close. For Fayette elementary schools, the correlation between the CATS index and the CTBS/5 score is .91 and the attendance rate is .78, while the correlation between the CTBS/5 and attendance rate is .81.

The data also show that contrary to the negative relationship between size and performance found in some previous research, for elementary schools in Fayette County, the relationship between size and performance is moderately strong and positive. Schools with larger enrollments tend to score higher on the CATS accountability index ($r = .48$), have higher attendance rates ($r = .50$), and score higher on the CTBS/5 test ($r = .56$). There are other possible indicators of school performance, however dropout rates are not applicable or available for elementary schools and reliable or valid measures of school disciplinary actions are not yet available.

Because of this seemingly counter-intuitive finding that larger elementary schools in Fayette County perform at higher levels than smaller schools, other plausible determinants of performance must be considered. Two obvious candidates for examination are race and poverty, both of which have been shown in previous research to complicate the performance – size relationship. First, as might be expected in a moderately large urban/suburban school district in a border-Southern state with a history of segregation and existing patterns of housing segregated by race and income, poverty and race are closely and positively related for these elementary schools ($r = .80$). Fayette County elementary schools with large proportions of low-income students also have large proportions of minority students. Second, larger elementary schools have smaller proportions of poor and minority students – the correlations of size with race and poverty are moderately strong and negative ($r = -.63$ and $-.65$, respectively). To summarize the bivariate relationships among these variables in Fayette County, smaller elementary schools have higher proportions of poor and minority students and weaker performance.

After examining bivariate relationships among these variables, the next step is to attempt to sort out inter-relationships to assess whether size contributes to an explanation of school performance when controlling for poverty and race. Table 2 presents multivariate models using these three plausible determinants of performance (size, race, and poverty) as well as one other control variable (percent teachers with masters) that could be considered a key educational resource. The models show that poverty is a significant and substantial predictor of performance while race and size have no significant independent effects on performance as measured by the CATS index, the CTBS/5 index, and attendance rates. With these controls, the proportion of teachers with at least a masters degree does help explain elementary school performance on the CATS accountability index and the CTBS test, but not attendance rates. It appears that having a higher proportion of more credentialed teachers may help offset the substantial negative effects of child poverty on performance.

The bivariate correlations among these predictor variables described previously, especially poverty and race ($r = .80$), suggest that multicollinearity could be causing some instability of the regression coefficients. Two related statistics - tolerance and VIF, both of which are derived from regressing each independent variable on all the other independent variables, can be used to assess multicollinearity (Garson, N.D.). Tolerance is defined as $1-R^2$ for the regression of one independent variable on the others in the model, so when tolerance is close to zero there is high multicollinearity of that variable with the others and the regression coefficients will be unstable. The variance-inflation factor or VIF is the reciprocal of tolerance and so high values indicate high multicollinearity. Garson suggests that a VIF >= 4 is an arbitrary but common standard for high multicollinearity in that the standard error of the coefficient is doubled when VIF is 4.0 and tolerance is .25. Since no individual VIF is greater than 4.0 and no mean VIF is greater than 2.5, multicollinearity does not appear to be a problem with the four models in Table 2.

In addition to these cross-sectional models using one-time measures of elementary school performance, another indicator of school performance is improvement over time. How do school size and these other variables relate to change in school performance? The bottom of Table 2 presents an OLS regression model using change in the CATS (KIRIS) index from 1993 to 2001. The estimated model shows that school size does predict negatively to improved performance controlling for other variables, but the relationship is weak, especially compared to the impact of poverty. The model also shows that when modeling change in accountability scores over time it is important to control for the base year score or starting point. The significant negative coefficient for base year or 1993 accountability score (-.76) indicates that schools scoring higher in 1993 are significantly more likely to have lower change scores controlling for the other variables in the model. Fayette elementary schools that began the KERA accountability process with low scores are much more likely to show greater improvements over time holding the other factors constant. After this control for baseline score, as with the cross-sectional models in Table 2, the strongest predictor of change in accountability scores is proportion of children eligible for subsidized meals (higher poverty predicts to less improvement over time) followed by proportion of teachers with masters degrees or higher (higher proportion predicts to more improvement) and enrollment size (higher enrollment predicts to less improvement).

TABLE 2
REGRESSION MODELS OF FAYETTE ELEMENTARY SCHOOL PERFORMANCE [1]

CROSS-SECTIONAL MODELS

	PERFORMANCE MEASURES		
	CATS	CTBS/5	ATTENDANCE
Enrollment	-.003 (0.3)	.000 (0.0)	-.001 (0.7)
Minorities	.071 (0.5)	.107 (0.8)	.004 (0.6)
Poverty	-.395 * (4.5)	-.571 * (6.5)	-.029 * (6.3)
Teachers/Masters	.261 * (2.4)	.214 * (2.0)	.006 (1.0)
Intercept	69.0 (5.8)	66.3 (5.6)	96.1 (157)
Adj R^2	.63	.78	.74
F	14.4	28.8	23.4
Mean VIF	1.6	1.6	1.6

MODEL FOR CHANGE IN ACCOUNTABILITY SCORES OVER TIME

Y = 75.7 intercept -.76 Indx93 * -.02 Enroll +.12 Minor -.46 Poverty * +.22 Tchrmst *
(5.8) (3.0) (1.9) (1.1) (5.6) (2.2)

Adj R^2 = .52
F = 7.8
Mean VIF = 2.4

1. Regression coefficients for the longitudinal and cross-sectional models are unstandardized with the t-score just below in parentheses. With this sample size of 32 schools, coefficients with an asterisk have a t-score of 2.0 that indicates significance at least at the .05 level.

Additional potential predictors of school performance including student/teacher ratio, spending per student, and classes taught by teachers with a major or minor in the academic area have only minor or no effects when added to the above models. One reason for this is that several of these indicators of school resources are very closely related. Larger elementary schools also have significantly more students per teacher (r = .85) and lower spending per student (r = -.79), but only somewhat higher proportions of teachers with masters degrees (r = .14). Fayette elementary schools with larger proportions of students from low-income families also have larger proportions of minorities, lower enrollments, higher spending per student, fewer students per teacher, and somewhat fewer teachers with masters degrees. As indicated in Table 3, this lack of effect for these other school variables in the regression models may relate to possible multicollinearity problems with certain school characteristics and suggests why they should not be included in the models. But again, the VIFs for the models reported in Table 2 suggest that these models without the additional predictors do not have multicollinearity problems.

TABLE 3
CORRELATIONS AMONG ELEMENTARY SCHOOL CHARACTERISTICS (N = 32)

	% pov	%minor	Enroll	Spend/std	Stds/tch	Tchs/mst
% minority	.80					
Enrollment	-.65	-.63				
Spend/student	.73	.74	-.79			
Students/tchr	-.87	-.77	.85	-.87		
Teachers/masters	-.17	-.24	.14	.01	.06	
Teachers/maj/min	-.35	-.25	.25	-.30	.35	-.15

These results suggest that local school officials should be wary of merging several smaller elementary schools in Fayette County, at least if the goal of merger is improved performance. Controlling for several important school characteristics, size has no significant effect on three of four measures of elementary school performance. Although this analysis does not support the finding from previous research that smaller schools have higher student achievement and higher rates of attendance, the impact of larger size on performance also is not evident when these other school characteristics are included in the models. Larger elementary schools in Fayette County do have higher student achievement and higher attendance rates, but this stronger performance is more the result of lower rates of poverty rather than school size. Controlling for race and size, schools with smaller proportions of poor students display much higher levels of performance than schools with larger proportions of poor children. Also, schools with more credentialed teachers perform at somewhat higher levels controlling for size, race, and poverty, but the relationship is much weaker than for child poverty. Although suggestive, before drawing any firm conclusions, since only elementary schools in one urban/suburban district in one state are examined, further analysis is necessary.

SIZE AND PERFORMANCE IN URBAN ELEMENTARY SCHOOLS

The previous analysis will be expanded in two ways. First, the sample of schools will be expanded by including elementary schools in the two largest school districts in Kentucky (Fayette and Jefferson Counties), and second, the previously discussed interaction hypothesis (Johnson, Howley, and Howley, February 2002) which assesses the degree to which "strength and directionality of the relationship of size to achievement is linked to (or contingent on) community socioeconomic status" will be examined.

Table 4 presents descriptive statistics for the expanded sample of urban (Fayette and Jefferson Counties) elementary schools and shows some small differences with the initial sample of Fayette County elementary schools described in Table 1. The differences also are reflected in the bivariate correlations between the variables shown in Table 5 compared to those in Table 3. Just as with elementary schools in Fayette County, poverty and race also are related in the larger sample of urban elementary schools, but somewhat less closely; and more importantly, enrollment or size is much less closely related to poverty and race in this expanded sample of urban elementary schools than in Fayette County.

TABLE 4
URBAN ELEMENTARY SCHOOLS DATA SUMMARY (2000)

Variable	# Obs	Mean	Std Dev	Skew	Min	Max
Enrollment	122	519	124	-.12	203	942
% minority	120	34.1	14.1	.48	5.3	72.4
% poverty	122	57.5	24.4	-.26	6.0	99.0
CTBS/5	122	49.0	16.0	.41	13.0	85.0
CATS	122	64.3	12.8	.48	39.0	96.1
Attendance	120	94.8	.98	-.20	91.8	97.2

TABLE 5
CORRELATIONS AMONG URBAN ELEMENTARY
SCHOOL CHARACTERISTICS (N = 32)

	% pov	%minor	Enroll	Spend/std	Stds/tch	Tchs/mst
% minority	.71					
Enrollment	-.35	-.28				
Spend/student	.79	.65	-.39			
Students/tchr	-.48	-.35	.54	-.43		
Teachers/msts	-.34	-.27	.16	-.09	.32	
Teachers/maj/min	-.35	-.21	.01	-.31	.00	.17

The first finding of this expanded analysis is that increasing the sample size alone has little effect on the models estimated previously for Fayette elementary schools. Although not shown here, the same regression models presented in Table 2 for Fayette elementary schools are not much different for the expanded sample of urban elementary schools in that size has no independent effect on performance when controlling for poverty and race, whereas poverty is the strongest predictor of performance. The only differences are that with the expanded sample, race and teachers with masters are both significant predictors of attendance rates. For the model that predicts change in accountability scores over time, the expanded sample finds only one important difference – size has no independent effect on improvement in accountability scores compared to a weak negative effect for the smaller sample of Fayette elementary schools.

After increasing the sample to include two urban counties and finding no important differences with the previous models for the initial sample of elementary schools in one urban county, the next step is to test the poverty/size interaction hypothesis using a model similar to that of Johnson, Howley, and Howley (February 2002), hereafter referred to as JHH. One difference with the JHH approach is that the size variable used here (enrollment or students per school) will not be transformed using the natural log. In contrast to the positive skew of 2.3 for their measure of size (students per grade), the measure of skew for enrollment used in this sample is only -.12 indicating a relatively normal distribution (Table 4). As with JHH, the two key independent variables – size and poverty that make up the interaction term are centered using the Cronbach

(1987) method of subtracting the mean of each variable from each individual value of that variable. This is done to reduce potential multicollinearity among the two variables and the interaction term.

The potential effect of centering on the regression models is suggested by comparing the correlations among the key variables before and after centering. Before centering, the correlation between poverty and the interaction term (poverty x size) is quite strong ($r = .79$), however the correlation between size and the interaction term is much weaker ($r = .25$). Centering both poverty and size and then using these for the interaction term substantially reduces the correlation between poverty and the interaction term from .79 to .09 but only reduces the correlation between size and the interaction term from .25 to .17. Centering or subtracting a constant does not change the correlation between the two variables being centered – the correlation between poverty and size remains moderately negative ($r = -.35$).

Table 6 presents multivariate models with four measures of performance regressed on the independent variables used in Table 2 with both size and poverty centered and the addition of the interaction between these two centered variables (size x poverty). Centering the two key predictor variables and entering the interaction term based on those two centered variables in the equations show little difference from previous models. Poverty remains the strongest predictor of performance while size alone and the interaction of size and poverty have no significant effects on performance. As evidenced by the relatively low mean VIFs for all four equations (none > 2.0), multicollinearity does not appear to be causing any estimation problems. For elementary schools in these two large urban school districts, size has no direct effect on performance and size has no indirect or conditional effect – smaller school size does not moderate the effects of poverty on performance.

TABLE 6
REGRESSION MODELS OF URBAN ELEMENTARY SCHOOL PERFORMANCE [1]

CROSS-SECTIONAL MODELS

	PERFORMANCE MEASURES		
	CATS	CTBS/5	ATTENDANCE
Enrollment (centered)	-.004 (0.8)	-.006 (1.0)	-.000 (0.9)
Minorities	.099 (1.6)	.094 (1.3)	.025 * (4.7)
Poverty (centered)	-.450 * (11.7)	-.597 * (13.2)	-.040 * (4.7)
Teachers/Masters	.183 * (3.3)	.143 * (2.2)	.012 * (2.5)
Poverty x Size	-.000 (0.3)	-.000 (0.5)	.000 (1.2)
Intercept	46.8 (9.8)	34.8 (6.2)	93.0 (223)
Adj R^2	.71	.75	.64
F	58.4	72.4	42.5
Mean VIF	1.5	1.5	1.5

MODEL FOR CHANGE IN ACCOUNTABILITY SCORES OVER TIME

Y = 45.0 intercept -.93 Indx93 * -.01 Enroll +.10 Min -.40 Pov * -.00 pov x size +.21 Tchmst *
(7.3) (7.2) (1.1) (1.5) (8.3) (0.7) (3.4)

Adj R^2 = .46
F = 17.9
Mean VIF = 1.8

1. Regression coefficients for the longitudinal and cross-sectional models are unstandardized with the t-score just below in parentheses. With this sample size of 120 schools (118 for attendance), coefficients with an asterisk have a t-score of 2.0 that indicates significance at least at the .05 level.

Although some previous research finds that smaller schools perform at higher levels than larger schools and smaller school size moderates the negative effects of poverty on performance, this analysis of elementary schools in two large urban/suburban school districts suggests that school type may be a more important determinant of school performance than size or the interaction of size and poverty. However, since the models have been tested only with elementary schools in these two urban/suburban school districts, at least one additional step is needed to more adequately test the hypothesis that size moderates the effects of poverty on school performance. The next section tests this interaction hypothesis on a sample of all schools in these two school districts in Kentucky.

SIZE, POVERTY, AND PERFORMANCE IN URBAN SCHOOLS

As noted above, estimation of regression models of school performance in earlier papers (Roeder, February 2000 and June 2000) finds that in almost all models when dummy variables for type of school (elementary and high schools) are included in the equations, size (enrollment) is not significant. More importantly, although poverty is the strongest predictor of performance on Kentucky's accountability index, type of school is significant controlling for poverty and size - elementary schools perform significantly better than middle and high schools in most models using the KIRIS and CATS accountability indices.

Table 7 presents models for all schools in the two largest districts in Kentucky that regress four measures of school performance on school characteristics that have been used and discussed previously with the addition of dummy variables for school type (elementary and high schools with middle schools as the omitted type) and interaction terms for poverty with both high schools and elementary schools. The interaction hypothesis that smaller school size moderates the negative impact of poverty on performance is tested and can be compared to the interaction hypothesis that the slopes of the interaction terms for type of school and poverty (poverty x high school and poverty x elementary school) will vary significantly. The hypothesis that regression coefficients for high school and elementary school dummy variables will be significantly different from zero (the intercepts for type of school will vary significantly) also are tested in Table 7.

Estimating two models for each of four measures of school performance allow comparisons of the impact of size and school type on performance, both directly and indirectly as they interact with poverty. Separate models with one using non-centered predictor variables and the other using centered predictors with interaction terms provide regression coefficients prior to introducing interaction terms into the models and to illustrate how centering and interaction terms may affect coefficients, and therefore influence interpretations and conclusions that might be drawn from the analysis.

In contrast with some previous research but similar to the above models in Tables 2 and 6, for these eight models of school performance, size is not significant. Although close to significance for the uncentered model of performance over time, enrollment is related significantly to performance only for attendance rates in the basic or uncentered model (Att_u). However, despite its statistical significance, the coefficient is positive indicating that larger schools have higher attendance rates holding these other variables constant. Size is not significant in any of the models when poverty and size are centered and interaction terms are included.

The next conclusion from estimation of these models is that the interaction hypothesis that smaller schools reduce the negative effects of poverty on performance can be rejected for all four measures of performance. The interaction term comes close to significance for attendance rates, however once again the sign is positive rather than negative. Just as with the regression models above that find no interaction effects for urban elementary schools, in these models for all urban schools, smaller size does not tend to reduce the negative effects of poverty on performance.

In contrast to the insignificance of size and the interaction of poverty and size, school type has significant direct and indirect effects on performance. Significant direct effects are indicated by the dummy variables for elementary and high schools that are significant in all the centered and uncentered models with the elementary dummies positive and the high school dummies negative. For example, in the CATS_u model the constant or intercept is 66.1 indicating that the mean

accountability score for middle schools (the omitted dummy category) would be 66.1 controlling for the other predictors in the model (the actual mean is 62.7). The high school partial regression coefficient of –7.0 indicates the high school mean accountability score would be 59.1 holding the other predictors constant (the actual mean is 62.7), while the elementary dummy coefficient of 8.1 indicates the elementary school mean accountability score would be 74.2 controlling for the other variables (the actual mean is 64.3). This means that with the same levels or proportions of size, poverty, minorities, and credentialed teachers, elementary schools perform at much higher levels than middle and high schools.

Indirect or contingent effects of school type are indicated by the regression coefficients or partial slopes for the poverty x elementary interactions that are significant for three of four performance measures (CATS, CTBS, and attendance) and close to significance for change in CATS/KIRIS accountability scores. The positive signs of the regression coefficients for the poverty x elementary interaction indicate that the slopes for the interaction terms should be added to the slopes for the poverty coefficients in the equation. For example, recalling that the measure of poverty has been centered on the mean, the significant coefficient of -.62 for poverty in the CATS_c model means that poverty for middle schools (the omitted category or school type) is significantly and negatively related to performance on the CATS accountability index. Higher rates of poverty predict to poorer performance for middle schools holding the other variables constant. Adding the significant partial slope of .16 for the poverty x elementary interaction to the significant partial slope of -.62 for middle school poverty indicates that the partial slope for poverty is somewhat lower for elementary schools (-.46) than for middle schools (-.62). The substantive interpretation is that both middle and elementary schools significantly reduce the impact of poverty on performance, but middle schools do so at a somewhat higher rate (the partial slope is steeper).

The equation for attendance (Att_c) shows the impact of both elementary and high schools as they relate to or interact with poverty. The significant partial regression coefficient of poverty with attendance rate is -.10 (middle schools), while the significant partial slopes for the elementary and high school interactions with poverty are .06 and -.15 respectively. This indicates that the partial slope for poverty with attendance is lower for elementary schools (-.10 + .06 = -.04) and higher or more steep for high schools (-.10 + -.15 = -.25).

TABLE 7
REGRESSION MODELS OF URBAN SCHOOL PERFORMANCE [1]

CROSS-SECTIONAL MODELS

	PERFORMANCE MEASURES					
	CATS_u	CATS_c	CTBS_u	CTBS_c	ATT_u	ATT_c
Enrollment	.002 (0.9)	-.003 (0.8)	.003 (1.0)	-.004 (1.0)	.002 * (4.0)	-.000 (0.1)
Minorities	.110 (1.9)	.087 (1.5)	.145 * (2.1)	.116 (1.8)	.038 * (3.3)	.031 * (4.2)
Poverty	-.495 * (13.9)	-.621 * (9.7)	-.663 * (16.1)	-.815 * (11.2)	-.060 * (8.5)	-.099 * (11.9)
Teachers/Masters	.178 * (3.5)	.153 * (3.1)	.168 * (2.8)	.137 * (2.4)	.026 * (2.6)	.017 * (2.6)
High School dum	- 7.0 * (3.1)	- 9.2 * (3.8)	- 8.8 * (3.4)	- 11.7 * (4.3)	- 4.6 * (10.4)	- 6.0 * (19.4)
Elementary dum	8.1 * (5.1)	7.6 * (4.5)	10.2 * (5.5)	9.4 * (4.9)	3.2 * (10.2)	2.9 * (13.3)
Poverty x size		-.000 (0.8)		-.000 (1.0)		.000 (1.6)
Poverty x high sch		-.129 (1.0)		-.179 (1.2)		-.147 * (8.4)
Poverty x elem		.160 * (2.3)		.192 * (2.4)		.063 * (6.8)
Intercept	66.1 (12.8)	44.1 (10.3)	57.8 (9.7)	28.1 (5.8)	90.7 (88.7)	89.8 (160)
Adj R^2	.70	.73	.75	.78	.71	.88
F	71.2	54.4	90.7	71.1	72.9	150
Mean VIF	2.1	4.2	2.1	4.2	2.1	4.1

TABLE 7 (continued)
REGRESSION MODELS OF URBAN SCHOOL PERFORMANCE *

MODEL FOR CHANGE IN ACCOUNTABILITY SCORES OVER TIME (uncentered)

Y = 48.1 intercept -.59 Index93 * -.00 Enroll +.09 Min -.39 Poverty * +.13 Tchrmst *
(7.8) (6.4) (1.8) (1.6) (9.4) (2.5)

+8.9 Elemdum * - 4.7 Hsdum *
(5.9) (2.1)

Adj R^2 = .47
F = 23.3
Mean VIF = 2.31

MODEL FOR CHANGE IN ACCOUNTABILITY SCORES OVER TIME (centered + interactions)

Y = 35.2 intercept -.72 Index93 * -.00 Enroll +.09 Min -.50 Poverty * +.16 Tchrmst *
(7.0) (7.4) (1.3) (1.6) (6.7) (3.3)

+7.2 Elemdum * - 5.6 Hsdum * -.00 pov x size -.11 pov x hs +.12 pov x elem
(4.4) (2.3) (1.3) (0.8) (1.6)

Adj R^2 = .47
F = 16.6
Mean VIF = 4.45

1. Regression coefficients for the longitudinal and cross-sectional models are unstandardized with the t-score just below in parentheses. With this sample size of 179 schools (177 for attendance), coefficients with an asterisk have a t-score of 2.0 that indicates significance at least at the .05 level. The models with the _u extension include size and poverty without being centered and no interaction terms; those with the _c extension include size and poverty centered on their means and three interaction terms for poverty x size, x the high school dummy, and x the elementary dummy variable.

Although the results of the analysis using several different samples and models are relatively consistent and unambiguous, the findings in Table 7 should be interpreted with some caution, primarily because the mean VIFs for the full models with centered variables and interaction terms are between 4.0 and 4.5 suggesting that multicollinearity may be a potential problem with the full models that include dummy variables and interaction effects. With this caution, an analysis of schools in two large school districts suggests that school type is a more important determinant of school performance than size or the interaction of size and poverty. Although some previous research finds that smaller schools tend to perform at higher levels and smaller school size reduces the negative effects of poverty on performance, the models estimated in this study fail to support those findings. Instead, school performance varies significantly by type of school in that elementary schools perform at higher levels than middle and high schools holding other variables constant, and type of school moderates the effects of poverty on performance.

CONCLUSIONS

Using data from schools in one large and one moderately large urban school district in Kentucky, this paper examines several issues relating to school size and performance. Multivariate analyses of these data find that that poverty has a substantial negative impact on school performance, school size has no direct effect on performance, school size does not moderate the effects of poverty on performance, school type has significant direct impacts on performance, and school type moderates the effects of poverty on performance.

What do these findings imply for education policy makers? If an important question for education officials is how to improve performance in large and medium-sized urban/suburban school districts, focusing on school size does not appear to offer answers. Not only does smaller school size not relate to higher performance or moderate the negative impact of disadvantage on school performance, larger school size does not relate to higher performance if the larger schools also have high proportions of disadvantaged children. Since school performance is so strongly and negatively related to disadvantage and since school size does not affect school performance, neither keeping smaller schools with large proportions of disadvantaged students nor creating larger schools with large proportions of disadvantaged students is likely to improve performance in these districts.

The findings suggest further that disputes over school mergers or consolidations may be costly diversions from the more important issues of disadvantage and equal opportunity, especially as they relate to school performance. Unfortunately, school performance, although continually emphasized by almost all public school reform advocates, is not the only problem faced by education officials. In some cases, improved school performance takes a back seat to other goals when the discussion turns to school size. For example, saving money is often advanced as the primary reason for increasing school size, while minimizing the pathologies of bureaucracy is often advanced as a significant reason for decreasing school size. Some experts argue that merging smaller schools will lower costs, usually because of increased economies of scale, while other experts advocate keeping or creating smaller schools because they are believed to have more effective school cultures than larger schools, often the result of strong community or neighborhood involvement. Despite the attraction and seeming popularity of these somewhat mutually exclusive goals, the results of this research suggest that merging smaller schools with large proportions of disadvantaged students into larger schools with large proportions of disadvantaged students is not likely to improve school performance.

As with much non-experimental, social science research, sorting out relationships among school characteristics and the causes and consequences of reforms or changes in these characteristics is usually not simple or straightforward. For example, it is reasonable to ask what would be the consequences of distributing disadvantaged students more equitably across schools in a district - would school size then matter for performance? Many advocates for disadvantaged children argue that for several reasons these students achieve at lower levels in larger schools. If this assertion is true, then the larger schools created by closing or merging smaller schools likely would perform at lower levels since their proportion of disadvantaged and therefore lower performing children would increase. This analysis of Fayette and Jefferson County schools does not speak directly to the assertion that low-income and minority children are more likely to succeed in smaller schools, but it does raise questions about this common belief. If smaller elementary schools with high proportions of poor and minority children and lower levels of performance are closed or

merged, and the disadvantaged children are dispersed to larger schools (with fewer poor and minority children and higher levels of performance before the dispersal), there are two related but not identical questions about the results – (1) would the achievement levels of these children decline in the larger schools, and (2) would the subsequent performance levels of these larger schools now with higher proportions of disadvantaged children also decline?

It is difficult to answer these questions in any reasonably systematic manner without better data and more useful quasi-experimental research settings. Unfortunately in the real world of local school politics, perhaps an easier question for both political and professional school system officials is whether it is always simpler and less costly (both monetarily and politically) to deal with overcrowding in some schools by closing or merging smaller schools or by building larger schools? I believe in most medium to large school districts the answer is often yes, however this easier question of school size avoids the more fundamental question of the location of schools and how attendance boundaries are drawn.

Some of the conflicting findings and ambiguity over how and under what conditions school size and poverty determine performance relate to urban/rural distinctions. In most urban areas with neighborhoods segregated by race and class, school attendance boundaries can be drawn in ways that vary from one extreme with very high proportions of disadvantaged students in a few schools to the other extreme with disadvantaged students distributed more equitably across all schools. Rural districts with few schools usually do not have the luxury (or burden) of being able to draw varied attendance boundaries, especially at the high school level.

This analysis suggests that disputes over school mergers or consolidations may be costly diversions from the more important issues of disadvantage and equal opportunity in education. Remedies for poor school performance should concentrate more on reducing the harmful effects of poverty on achievement rather than simply creating smaller or larger schools. Policy makers in urban/suburban districts with many schools and diverse neighborhoods should consider drawing attendance boundaries to distribute poor children more equitably across schools, regardless of school size.

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APPENDIX A

FAYETTE COUNTY ELEMENTARY SCHOOLS (2000)						
SCHOOL	Enrollm	% povty	% minor	CATS	Attend	CTBS
RUSSELL	203	97	70	60.4	93.9	35
ATHENS	215	48	11	72.5	94.6	49
JOHNSON	223	97	52	51.0	94.4	35
BT WASHINGTON	235	96	72	48.6	93.8	25
ARLINGTON	289	92	24	66.4	94.5	45
ASHLAND	301	80	43	51.3	94.6	41
RUSSELL CAVE	308	75	61	59.5	94.1	48
HARRISON	334	99	42	49.4	92.6	30
LINLEE	342	61	39	63.5	95.4	46
NORTHERN	350	78	67	53.7	94.8	38
MEADOWTHORPE	357	42	30	82.2	95.2	82
MAXWELL	363	14	31	95.4	96.0	85
MARY TODD	373	72	52	52.9	94.5	41
PICADOME	390	30	14	69.4	95.4	60
J LANE ALLEN	423	47	17	57.2	95.2	44
YATES	470	52	36	61.4	94.4	59
CASSIDY	498	30	14	82.5	95.3	78
DEEP SPRINGS	500	54	28	52.2	94.6	47
GARDEN SPRINGS	511	17	7	70.5	96.1	66
DIXIE	523	39	23	75.9	95.5	51
JULIUS MARKS	523	22	13	67.8	95.6	65
MILLCREEK	539	38	26	65.9	95.2	61
TATES CREEK	563	66	31	62.4	94.6	46
BRECKINRIDGE	570	62	33	67.7	94.6	42
JULIA R EWAN	591	49	28	74.2	94. 7	62
SQUIRES	607	23	14	69.2	95.6	61
ROSA PARKS	616	6	-	88.1	96.2	72
LANSDOWNE	625	41	16	87.0	95.7	72
CARDINAL VALLEY	640	79	32	55.5	93.8	40
VETERANS PARK	654	6	-	96.1	97.0	84
GLENDOVER	659	27	25	87.1	95.7	73
CLAYS MILL	677	12	12	90.1	95.4	79
SOUTHERN	688	34	12	67.9	95.4	66
STONEWALL	693	7	5	84.7	96.4	84

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