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Competition and the Quality of Public Schools

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Abstract—A growing body of empirical research has provided provocative evidence that competition from private schools improves student achievement in neighboring public schools. However, this uniform conclusion has been based on fundamentally different empirical specifications. This study examines the importance of these different specifications by presenting new evidence on the relationship between public school quality and competition from private schools. This evidence is based on a unique data set that contains consistently defined high school graduation rates for the unified school districts in 18 states. The results indicate that empirical strategies which rely exclusively on ordinary least-squares (OLS) can lead to misleading inferences because of omitted variables bias and the simultaneous determination of the demand for private schools and public school quality. Nonetheless, two-stage least-squares (2SLS) estimates indicate that competition from private schools does have a positive and statistically significant impact on the high school graduation rates of neighboring public schools. [*JEL* I2, H7, H4] © 1998 Elsevier Science Ltd. All rights reserved

1. INTRODUCTION

THE FUNDAMENTAL premise for educational policies that advocate school choice is that increased competition can improve the quality of public schools. Surprisingly, researchers have only recently begun to generate direct evidence on whether this influential view is accurate (Borland and Howsen, 1992; Couch *et al*., 1993; Hoxby, 1995; Arum, 1996). All of this research has concluded that the presence of competition from private schools does increase the level of student achievement in public schools. However, this uniform conclusion has been based on fundamentally different empirical specifications. In particular, most of this early evidence may be misleading since it is based solely on ordinary least-squares (OLS) estimates of the determinants of student achievement in public schools. There are two important specification issues that make the interpretation of a positive partial correlation between achievement in public schools and the presence of competition from private schools problematic.

One straightforward concern is the existence of omitted variables bias. There is ample evidence that the equilibrium demand for private schools is significantly affected by several dimensions of socioeconomic status (Gemello and Osman, 1984; Martinez-Vazquez and Seaman, 1985; Long and Toma, 1988; West and Palsson, 1988; Hamilton and Macauley, 1991; Lankford and Wyckoff, 1992). Furthermore, it is well known that such socioeconomic characteristics are also strongly correlated with the level of student achievement (Haveman and Wolfe, 1995; Hanushek, 1986). It follows that, if an empirical model did not adequately condition on the socioeconomic priors of students and their communities, a partial correlation between competition and the quality of public schools could lead to misleading inferences.[1] A second fundamental specification issue is that the demand for private schooling is, in all likelihood, not an independent determinant of the quality of local public schools. Other things being equal, an increase in the quality of local public schools should reduce the demand for private schools (Hoxby, 1995).[2] These specification issues have very different implications for the inferences based on single-equation estimation procedures like ordinary least-squares (OLS). The existence of omitted variable bias implies that OLS may overestimate the true effect of competition from private schools on public school achievement by confounding the presence of private schools with other important but unobserved determinants of student achievement. The existence of simultaneity implies that OLS may underestimate the effect of private schools on achievement in public schools because high-quality public schools can draw students away from private schools.

In this paper, I examine the importance of these specification issues by generating new evidence on the relationship between competition from private schools and achievement in public schools. This evidence is based on a unique data set that contains con-

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sistently defined high school graduation rates for the unified school districts in 18 states as well as Census data on the characteristics of the communities, parents and children in these districts. Estimations with these data suggest that omitted variable bias is an important issue when modeling the effect of competition from private schools on public school quality. For example, in the limited empirical models that omit measures of parental education and household income, there exists a positive partial correlation between competition from private schools and the high school completion rate in public schools. However, this partial correlation does not exist in empirical models that condition on these important determinants of student achievement.

These estimations also underscore the importance of the simultaneity between the quality of public schools and the equilibrium demand for private schools. Adopting the approach employed in other recent research (Evans and Schwab, 1995, Hoxby, 1995 and Neal, 1997), some of the estimates presented here exploit the exogenous variation in private schooling generated by the population concentration of Catholics. The two-stage least-squares (2SLS) estimates based on this identification strategy demonstrate that OLS dramatically underestimates the effect of competition from private schools on the rate of high school completion in public schools. The direction of the bias in OLS estimates suggests that the demand for private schooling increases when public schools have low quality. The 2SLS estimates indicate that increased competition from private schools has a positive and statistically significant impact on the level of student attainment in public schools. Both the pattern of these results and the magnitude of the implied elasticities parallel those reported by Hoxby (1995).

The paper is organized as follows. In the next section, I present the data. Then, I discuss the empirical strategy and the evidence that the population concentration of Catholics provides valid instruments for identifying the effect of competition from private schools on public school quality. Then, I present OLS and 2SLS estimates of the effect of competition from private schools on the level of high school graduation in public schools. The final section contains conclusions.

2. DATA

Much of the data used in this study has been drawn from the National Center for Educational Statistics' (NCES) Common Core of Data (CCD). The CCD is a "comprehensive, annual, national statistical database of all public elementary and secondary school districts, which contains data that are comparable across states." The 1993–94 CCD files contain dropout data by school district and by grade for 18 states that report dropouts according to a consistent definition.[3] The student outcome modeled in this paper is the district-level high school graduation rate implied by these data. The data set consists of the 4488 unified school districts that were operational in these states. The graduation rate implied by these data does not track a single cohort but instead reflects, not unlike a moving average, the rate of grade completion by four cohorts. Given the number of dropouts from grade j of district i, D_{ij}, and the fall enrollment in that same grade and district, E_{ij}, a grade completion rate can be formed as:

$$G_{ij} = \frac{E_{ij} - D_{ij}}{E_{ij}} \in [0,1].$$

Since each grade completion rate is conditional on having arrived at that grade, an implied high school graduation rate for a district can be calculated as the product of four grade completion rates:

$$Q_i = \prod_{j=9}^{12} G_{ij} \in [0,1].$$

This graduation rate has an unweighted mean of 88.1 percent and ranges from 46.9 percent to 100 percent.[4] Because this measure of educational attainment is defined by the schooling decisions made by school-age teens, those who eventually go on to obtain high school equivalencies are not identified as graduates. There is some evidence that this construction is an appropriate one (Cameron and Heckman, 1993).

One point on which there is substantial agreement in the literature on educational achievement is that family and community characteristics are strong predictors of student performance (Haveman and Wolfe, 1995; Hanushek, 1986). More specifically, this literature has shown that family wealth, family structure and parental education are all significant correlates of achievement.[5] The CCD includes a broad range of appropriate covariates taken from the 1990 Decennial Census and defined by public school district boundaries. Included among these variables are the median household income in households with children, the reported race of children within a school district and the educational attainment of householders in a district. Two relatively unusual regressors that reflect the likelihood of a child to do well in school are also included: the percent of children who don't speak English well and the percent of children who are defined as "at risk." The definition, "at risk," reflects family structure as well as poverty status and parental education. Additionally, some estimations also include 1991–92 per-pupil instructional expenditures as a covariate. Though there is evidence that instructional expenditures are not an independent determinant of student achievement (Dee, 1997), the inclusion of this variable provides a robustness check on the estimated parameter of interest. These estimations also condition on state effects and on six dummy variables that reflect the degree of urbanicity in the school district. Table 1 reports the summary

Table 1. Summary statistics: unified school districts in 18 states

Variable	Mean (standard deviation)	Minimum	Maximum
High school graduation rate	88.1% (9.6)	46.9%	100.0%
% County students in private school	7.5% (7.6)	0.0%	57.0%
% County population Catholic	20.8% (18.1)	0.0%	100.0%
% Non-white children	12.5% (17.5)	0.0%	100.0%
% Children at risk	2.9% (3.7)	0.0%	38.4%
% Children who speak English "Not well" or "Not at all"	1.3% (2.4)	0.0%	34.1%
% Householders with high school degree or less	61.6% (15.2)	7.5%	100.0%
% Householders with some college	22.4% (7.0)	0.0%	50.7%
Log of median income in households with children	10.3 (0.3)	8.9	11.8
Log of instructional expenditures per pupil	8.0 (0.3)	7.3	9.8

statistics for the key variables. The characteristics of districts in this 18-state data set are similar to those of other unified school districts (Dee, 1997).

Data on private school enrollment by county have been drawn from the National Center for Education Statistics' 1991–92 Private Schools Survey. The 1991–92 Private Schools Survey is a universe survey comparable to the CCD for public schools. Competition from private schools is measured at the county level by the proportion of all students enrolled in private schools in the 1991–92 school year.[6] Data on public school enrollments for the 1991–92 school year were drawn from the CCD. Data on the proportion of county's population that is Catholic have been constructed using population data from the 1980 Decennial Census and data on the number of Catholics from the Association of Statistics of American Religious Bodies (ASARB).[7]

3. EMPIRICAL STRATEGY

As in previous research, the equation of interest is one which models the determinants of student achievement. More specifically, I report estimates that use the following specification:

$$Q_{sci} = W_{sci}\Pi + P_{sc}\gamma + u_s + \epsilon_{sci}. \quad (1)$$

Q_{sci} represents the graduation rate of district i in state s and county c, W_{sci} is a vector of district i's socioeconomic characteristics, u_s is a state effect and ϵ_{sci} is a mean-zero error term. P_{sc}, the proportion of all elementary and secondary students in state s and county c that are enrolled in private school, measures the level of competition from private schools. The choice of this functional form does not appear to be particularly relevant. Both log-linear and log-odds formulations of this relationship generate results similar to the ones reported here.[8] However, because the school districts are of varying sizes, the error term may be heteroskedastic. Therefore, consistent standard errors are reported for both OLS and 2SLS estimations (White, 1980, 1982).

The expressed concern with OLS estimations of Equation (1) is that they may produce biased estimates of γ either because of some omitted elements of W_{sci} that are correlated with P_{sc} or because Q_{sci} and P_{sc} are simultaneously determined. One straightforward approach to examining the importance of omitted variable bias is to evaluate OLS estimates of γ in models that exclude some key variables in W_{sci}. The most limited versions of Equation (1) reported here exclude the measures of parental education and household income though these attributes are known to influence both educational attainment as well as the choice of private schooling (Haveman and Wolfe, 1995; Long and Toma, 1988). However, a more general approach to investigating both concerns about omitted variables and simultaneity is to generate 2SLS estimates. In order to generate 2SLS estimates of Equation (1), the following first-stage equation is estimated:

$$P_{sci} = W_{sci}\Omega + C_{sci}\delta + u_s + \nu_{sci}. \quad (2)$$

The i subscript is included here to indicate that the school districts, which are often intra-county, are the units of observation in these estimations. The instrumental variables, C_{sci}, consist of a vector of four indicators for the population concentration of Catholics in state s and county c. More specifically, these instrumental variables have been formed by ranking school districts, in descending order, by the proportion of the county population that is Catholic. The instrumental variables are the dummy variables associated with each quintile in this ranking. This approach, which creates four instrumental variables out of the population concentration of Catholics, overidentifies the

system and allows the orthogonality assumption to be tested formally.[9]

The quality of this identification strategy hinges critically on whether the population concentration of Catholics provides a valid instrument for the popularity of private schools. More specifically, the salient criteria are that the concentration of Catholics is an important determinant of the presence of private schools and that this concentration is otherwise independent of the level of student achievement in public schools. There is uncontroversial evidence that the first of these conditions is satisfied. Because a large proportion of private school enrollments are in Catholic schools, a high population concentration of Catholics implies an increased preference for private schooling (Gustman and Pidot, 1973; Gemello and Osman, 1984; Martinez-Vazquez and Seaman, 1985; Long and Toma, 1988; West and Palsson, 1988; Hamilton and Macauley, 1991; Lankford and Wyckoff, 1992; Evans and Schwab, 1995; Hoxby, 1995 and Neal, 1997). Furthermore, a high concentration of Catholics can reduce the costs of establishing private schools through several mechanisms (Hoxby, 1995). Church fund-raising reduces the cost of tuition in Catholic schools. Scale effects can also reduce the costs of Catholic schools through savings on transportation, various fixed costs and the availability of religious and volunteer staff. Therefore, it is not surprising that the concentration of Catholics proves, here as in prior studies, to be a strong determinant of the equilibrium demand for private schooling. OLS estimates of Equation (2), which are presented in Table 2, demonstrate the magnitude of this relationship. Each model indicates that lower concentrations of Catholics within a county implies significantly lower levels of enrollment penetration from private schools. Furthermore, these effects are plausibly monotonic. For example, in the second quintile, the proportion of county students in private schools is 3.8 percentage points lower than in those counties with the highest concentration of Catholics. In the fifth quintile (i.e., districts in those counties with the lowest proportion of Catholics), the popularity of private schools is roughly 8 percentage points lower. These monotonic effects are statistically significant. The estimated coefficients of the instrumental variables are all, in absolute value, at least 14.6 times larger than their standard errors.

It is less clear, *a priori*, that the population concentration of Catholics influences the quality of public schools only through this strong effect on the presence of private schools. More specifically, the quality of this identification strategy could be in doubt if the population concentration of Catholics also represented the effects on public school quality of living in a Catholic household or having a higher degree of religiosity (Evans and Schwab, 1995; Hoxby, 1995). This sort of orthogonality violation could be particularly problematic with these district-level data since there are no readily available controls for such individual-level attributes. However, there are several reasons to think that this concern is overdrawn. The tests of overidentifying restrictions (Newey, 1985) which are presented in the next section provide some formal evidence that the instrumental variables can rightfully be omitted from estimates of Equation (1). Furthermore, there is other more *ad-hoc* but suggestive evidence that these instrumental variables are not confounded with unobserved determinants of public school quality. For example, the mean educational attainment among Catholics actually appears to be similar to or somewhat less than that of Protestants and Jews (Taubman, 1975; Evans and Schwab, 1995; Hoxby, 1995). Also, the magnitudes of the 2SLS esti-

Table 2. First stage estimates: % county students in private school*

Independent variables	Model (1)	Model (2)	Model (3)
% Catholic quintile 2	– 0.038 (14.6)	– 0.038 (14.9)	– 0.038 (14.7)
% Catholic quintile 3	– 0.060 (21.0)	– 0.060 (21.6)	– 0.059 (21.3)
% Catholic quintile 4	– 0.066 (17.7)	– 0.063 (17.3)	– 0.062 (17.0)
% Catholic quintile 5	– 0.081 (18.1)	– 0.077 (17.1)	– 0.076 (16.9)
% Non-white children	0.072 (10.3)	0.072 (10.6)	0.069 (10.1)
% Children at risk	– 0.172 (5.8)	0.062 (1.9)	0.066 (2.1)
% Children who speak English "Not well" or "Not at all"	– 0.247 (7.1)	– 0.116 (3.2)	– 0.114 (3.1)
% Householders with high school degree or less	—	– 0.035 (3.3)	– 0.027 (2.5)
% Householders with some college	—	– 0.029 (1.6)	– 0.015 (0.7)
Log of median income in households with children	—	0.052 (10.8)	0.053 (10.9)
Log of instructional expenditures per pupil	—	—	0.014 (2.9)
R-squared	0.508	0.537	0.538

Note: *Heteroskedastic-consistent (White, 1980, 1982) absolute values of *t*-statistics are reported in parentheses. All models include state dummy variables and six dummy variables for the school district's degree of urbanicity.

mates of γ based on these instruments closely resemble those reported by Hoxby (1995) who estimated individual-level models similar to Equation (1) that did condition on covariates representing religiosity and living in a Catholic household.

The first-stage estimates reported in Table 2 also provide some *ad-hoc* evidence that the population concentration of Catholics is not confounded with other determinants of public school quality. Model (1) excludes information on parental education, family income and the level of per-pupil instructional expenditures while Model (2) excludes the expenditure variable. However, the coefficients on the instrumental variables are fairly stable across these three specifications. This suggests that there is only a weak covariance between the population concentration of Catholics and other important socioeconomic determinants of student achievement. Finally, to the extent that these instruments are plagued by minor orthogonality violations, the relevance of this for the consistency of the 2SLS estimates relative to OLS estimates should be limited since the instruments are so strongly correlated with the endogenous regressor (Bound *et al*., 1995).[10] In sum, because the concentration of Catholics generates considerable variation in the popularity of private schools and appears otherwise independent of the quality of public schools, the 2SLS procedure can generate unbiased estimates of γ, the parameter of interest in Equation (1).

4. RESULTS

Both OLS and 2SLS estimates of Equation (1) are reported in Table 3. Consistent with the extensive, prior research modeling student achievement, these estimates indicate that socioeconomic priors are strongly correlated with student outcomes. More specifically, school districts with high proportions of non-white students, of children at risk and of children who don't speak English well have significantly lower rates of high school graduation. For example, an increase of 3 percentage points in the proportion of children defined as "at-risk" is associated with a reduction in high school completion rates of as much as 1.6 percentage points ($0.03 \times - 0.529$). School districts in areas where parents have higher educational attainment or where households have higher incomes have higher graduation rates. There is also a significant partial correlation between instructional spending within a district and its graduation rate.[11]

An OLS estimation of Equation (1) can also replicate previous findings that there is a partial correlation between competition and student achievement (Borland and Howsen, 1992; Couch *et al*., 1993; Arum, 1996). For example, the OLS estimation of Model (1) which excludes variables reflecting parental education, median household income and the level of district expenditures suggests that competition from private schools significantly improves the attainment of students in public schools. However, this partial correlation is not robust to the inclusion of other socioeconomic attributes. This suggests that previous OLS results that have not conditioned on a broad array of other determinants of student outcomes should be interpreted with caution. A partial correlation between the popularity of private schools and the quality of public schools may reflect the effects of omitted variables instead of the causal effect of competition. These estimations, like those in Hoxby (1995), indicate that, conditional on other important determinants of student achievement, there is no partial correlation between competition from private schools and high school completion among public school students.

However, the more relevant specification issue appears to be the simultaneity between Q_{sci} and P_{sc}. Estimates of all three models indicate that OLS consistently and dramatically underestimates the effect of competition from private schools on the level of achievement in public schools. The test of overidentifying restrictions suggests that these 2SLS estimates are valid. In all three models, the hypothesis that the instrumental variables can be excluded from Equation (1) is not rejected. Interestingly, the downward bias in OLS estimates of γ suggests that the demand for private schools is higher in areas where public schools are low in quality. The 2SLS estimates of Equation (1) consistently indicate that increased competition from private schools has a positive and statistically significant effect on the level of educational attainment in public schools. The *t*-statistics for the null hypothesis that $\gamma = 0$ are 3.8 or larger in all three models.[12] However, the estimated elasticity of the high school graduation rate with respect to the level of competition from private schools is no larger than 0.025 ($0.295 \times [0.075/0.881]$) when defined for the mean level of each variable.[13] While this point elasticity may seem small, it could be argued that the effect of competition on the attainments of public school students is by no means trivial. Though, on average, the private schools in this study account for only 7.5 percent of county enrollments, the standard deviation is a large 7.6 percentage points. So, an exogenous increase of one standard deviation in the proportion of students enrolled in private schools, implies that the high school graduation rate in public schools would rise by at least 1.7 percentage points (0.228×0.076). Given the broad welfare implications of improvements in educational attainment, such a gain would represent a substantial policy achievement.

Another important dimension to the relationship between competition and public school quality concerns its heterogeneity. Hoxby (1995) finds that the educational attainment of Blacks was not responsive to the presence of competition and speculates that this is because, at the margin, Black students are relatively unlikely to consider private schooling. This interpretation suggests that the educational benefits of competition may be disturbingly limited in that they only

Table 3. OLS and 2SLS estimates: high school graduation rate equation*

Variable	Model (1)		Model (2)		Model (3)	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
% County students in private schools	0.042(2.2)	0.295(4.9)	− 0.011(0.6)	0.268(4.4)	− 0.023(1.2)	0.228(3.8)
% Non-white children	− 0.047(3.3)	− 0.065(4.4)	− 0.050(3.6)	− 0.070(4.8)	− 0.060(4.3)	− 0.077(5.2)
% Children at risk	− 0.571(9.0)	− 0.529(8.3)	− 0.426(6.4)	− 0.448(6.6)	− 0.408(6.2)	− 0.429(6.4)
% Children who speak english "Not well" or "Not at all"	− 0.413(5.0)	− 0.405(4.9)	− 0.381(4.5)	− 0.407(4.7)	− 0.379(4.5)	− 0.402(4.8)
% Householders with high school degree or less	—	—	− 0.129(8.2)	− 0.117(7.2)	− 0.096(6.0)	− 0.089(5.4)
% Householders with some college	—	—	− 0.239(8.9)	− 0.226(8.2)	− 0.178(6.5)	− 0.173(6.2)
Log of median income in households with children	—	—	0.024(3.1)	0.010(1.2)	0.027(3.5)	0.014(1.7)
Log of instructional expenditures per pupil	—	—	—	—	0.055(7.4)	0.049(6.5)
R-squared	0.319	0.314	0.343	0.336	0.352	0.346
Test of overidentifying restrictions†	—	2.69	—	3.14	—	3.59

Notes: *Heteroskedastic-consistent (White, 1980, 1982) absolute values of *t*-statistics are reported in parentheses. All models include state dummy variables and six dummy variables for the school district's degree of urbanicity. †This test statistic is distributed as a chi-squared (Newey, 1985). The 95% critical value is 7.82 since there are 3 degrees of overidentification. In all three 2SLS estimations, we cannot reject the null hypothesis that the models are correctly specified.

exist for those students who seriously consider switching schools. In contrast, the advocates of increased competition emphasize that competitive pressures should improve the quality of public schooling for all students regardless of which individuals seriously evaluated the choice between public and private schooling.[14] Estimations based on these data support the latter view. More specifically, in school districts whose boundaries encompass relatively high proportions of non-white students, the high school completion rate in public schools is still quite responsive to the level of competition from private schools.[15] These results suggest that educational benefits of competition may not be limited to only those students who can choose among schooling options.

5. CONCLUSIONS

The results presented in this paper indicate that exogenous variation in competition from private schools does appear to improve the quality of public schools. More specifically, increased competition from private schools implies that public schools have higher high school graduation rates. While these conclusions parallel those in all the early research on this question, they have also underscored some important caveats. Specifically, these estimations have demonstrated that the success of private schools can proxy for omitted determinants of student achievement in public schools and that the demand for private schools and the quality of public schools are simultaneously determined. The joint determination of the quality of public schools and the demand for private schools has proven to be an especially important specification issue for evaluating the consequences of competition.

The finding that competition can improve student outcomes has important policy implications. Most significantly, it suggests that introducing more choice into public education can improve student outcomes.[16] However, it also raises intriguing and largely unanswered questions. One such question concerns exactly how school districts change their behavior in response to increased competition from private schools. Constructing a complete answer to this question will undoubtedly prove central to designing policies that effectively harness the edu-

cational benefits of competition. Arum (1996) has suggested that competition from private schools improves public schools because it implies an increase in available resources. However, because the relationship between resource levels and student achievement is notoriously controversial (Burtless, 1996), this result may not prove to be particularly illustrative. A more complete answer to this question may eventually be based on more explicit models of within-district responses to competition. For example, there is some evidence that high levels of competition encourage school districts to allocate more of available resources to the classroom (Hoxby, 1995; Dee, 1997). Regardless, the evidence presented here suggests that any convincing, future evidence on how competition improves public schools will have to recognize the joint determination of the demand for private schooling and the attributes of neighboring public schools.

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NOTES

1. The district-level empirical model in Borland and Howsen (1992) does not condition on family income, family structure or parental education. The district-level empirical model in Couch *et al*. (1993) also does not condition on family structure. Similarly, Arum (1996) employs a state-level measure of competition from private schools without including rich controls for cross-state heterogeneity. Furthermore, all three papers only employed test scores as a student outcome though the effects of such scores on subsequent labor market success are modest relative to those of educational attainment (Bishop, 1991; Hanushek *et al*., 1992). Additionally, Newmark (1995) raises some questions about the robustness of Couch *et al*. (1993) 's results.
2. Hoxby (1995) explicitly addresses this possible simultaneity and models several student outcomes (e.g., test scores, educational attainment and wages). She finds that inferences based on the partial correlation between private school competition and student achievement are misleading.
3. A dropout is a student who was enrolled at any time during a particular school year and was not enrolled in October of the next school year and had not graduated, transferred and was not absent due to temporary disciplinary action. The 18 states that consistently employ this definition are Arizona, Arkansas, California, Connecticut, Delaware, Kansas, Massachusetts, Mississippi, Missouri, Nebraska, Nevada, New Mexico, New York, North Dakota, Oregon, Pennsylvania, Rhode Island and Texas.
4. The 14 unified school districts with graduation rates below 45% were excluded from this study since these low rates may have been driven by coding errors in the enrollment data. However, the results presented here are robust to including these outliers.
5. Lankford and Wyckoff (1992) point out that, in aggregated data like these, there is some ambiguity in interpreting the impact of such attributes on achievement. For example, the level of income may reflect an individual student's family wealth or that of his or her peers.
6. Similar county-level formulations were used by Couch *et al*. (1993) and Hoxby (1995). Borland and Howsen (1992) used a county-level Herfindahl index. Arum (1996) used a state-level measure.
7. The data on the number of Catholics by county were drawn from a survey of over 200,000 congregations with total membership of nearly 115 million. See Quinn (1982) for more information on these data.
8. However, any log-odds specification is somewhat *ad hoc* because an arbitrary correction has to be made to school districts with high school graduation rates of 100 percent.
9. The reference in these estimations is a school district in a county in the top 20 percent in terms of the proportion of Catholics. Overidentifying the system by creating categorical variables from one variable may reduce the ability of the test of overidentifying restrictions to detect orthogonality violations. However, the 2SLS estimates and overidentification tests based on using percent Catholic and its square as instruments suggest that this is not problematic. Furthermore, other evidence discussed in the text suggest that orthogonality violations are not a problematic feature of this empirical strategy.
10. The F-statistics on the instrumental variables are at least 145.6 for the models presented in Table 2. This strong first-stage relationship also suggests that the finite-sample bias associated with weak instruments is not an important specification issue in this context (Bound *et al*., 1995; Staiger and Stock, 1994).
11. Other researchers have reported similar correlations using such district-level data (Ferguson, 1991; Sander, 1993 and Ferguson and Ladd, 1996). However, this partial correlation may reflect omitted variables and obscure a more complicated relationship between the allocation of school expenditures and student achievement (Dee, 1997).
12. The inclusion of additional covariates in Models (2) and (3) does lower the magnitude of the competitive effect somewhat. However, because instructional expenditures are themselves endogenous (Dee, 1997), the relevance of this mild sensitivity is uncertain.
13. The lowest elasticity implied by these estimates is 0.019. IV estimates from Hoxby (1995)'s high school graduation model imply that the elasticity of high school completion with respect to competition is 0.013. That estimate and the ones presented here are not fully comparable since the model in Hoxby (1995) included private school students and the measure of competition was the penetration rate of Catholic schools.

14. Black students are relatively unlikely to attend private schools and, in particular, Catholic schools. However, since Blacks still attend public schools in areas where the population concentration of Catholics generates exogenous variation in the level of competition, the 2SLS estimates are still relevant under this hypothesis.
15. In the 1006 school districts where the percentage of non-white children is at least 20 percent, the 2SLS estimate of γ is 0.450 with a standard error of 0.215. The additional covariates are those used in Model (2) of Table 3. The first-stage relationship is quite strong in this subsample and the test value for the test of overidentifying restrictions is 0.5.
16. However, this choice may not need to come exclusively from private schools. Hoxby (1994) finds that competition from neighboring public schools also improves student outcomes.

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