School Choice In Rural Georgia: An Empirical Analysis

Andrew Keeler and Warren Kriesel*

Abstract

Previous empirical studies of school choice have been at the national level, or have focussed on northeastern states. We estimate the demand for private education in rural Georgia, using proportion of private school attendance as an indicator variable. We find that income, tuition, race and school quality are important choice determinants. The results provide useful information for rural school administrators, and suggest that a tuition tax credit would have to be substantial to cause a significant exodus from public schools.

Keywords: school choice, educational finance, rural areas, tuition tax credits

A large part of the debate on school choice and educational financing has revolved around the effect of public policies on parents' choice of private versus public schools for their children. This choice has important implications for school financing and school quality, as well as broader implications for the nature of economic and social opportunity. Proposals to offer vouchers or tuition tax credits for private education have been particularly prominent.[1] Theoretical and empirical research has shown that the decision to attend private schools is complex, and depends on social and cultural factors, parents' perceptions of school quality, and the relative prices of private and public education (Lankford and Wyckoff; Hamilton and Macauley). Empirical research has been performed at various levels of aggregation, but to date disaggregated research has focussed on the school choice in the northeast in predominantly urban areas. The purpose of this analysis is to extend this empirical research to school choice in the rural south - in particular to school choice in rural Georgia.

The history of conflict over public education and the rapid growth of private schools in the region after school integration suggest that parental reaction to key variables may differ from those observed in the urban, northeastern, and nation-wide investigations in the literature. This paper focuses on the demand for private education as a function of key characteristics of both the public and private alternatives. The implications of this research for education administration and financing, given the current debate about widening school choice through interventions such as vouchers and tax credits, are no less important for rural areas than for urban ones.

Another motivation for this research is to gain insight into why parents remove their children from the public school system. Public education administrators in the rural South are concerned about losing students to private schools. They realize that the loss of students entails both the loss of financial support and parental support for school functions (Flowers). Information about how parents

*Keeler is an assistant professor and Kriesel is an associate professor, both in the Agricultural and Applied Economics Department, University of Georgia, Athens, GA. Senior authorship is shared. The authors are grateful for the comments by two anonymous reviewers and for the helpful suggestions of Tim Park. A previous version of this paper was presented at the 1993 meetings of the Southern Regional Science Association and the American Agricultural Economics Association.

J. Agr. and Applied Econ. 26 (2), December, 1994: 526-534

respond to public school characteristics will answer the question of whether administrators can improve the public's perception of the schools and thus increase the likelihood that parents will choose public schools.

Much of the theoretical research on this topic has focused on the ways that taxpayer/voter preferences about school finance map into choices about educational expenditure and quality. Expenditure on education has been used as a proxy for school quality (Stiglitz); he hypothesized that private schools are better than public schools because per-pupil expenditure is higher. Flowers focused on the relationship of private and public school quality - lowering the cost of private education decreases the number of children in the public schools, but also decreases the willingness of the average resident to fund public education. She found that while a tax credit would tend to increase enrollment in private schools, it could conceivably increase the quality of public education. This would happen if the marginal cost of educational quality increased with the number of students enrolled while the tax credit decreased enrollment. Although higher expenditures cause higher educational quality in Flowers' work, she recognized that private and public education had different cost functions.

Given this emphasis on the relationship of cost differences and school choice in the literature, the actual behavior of parents when confronted with differing circumstances is an essential input for public debate. We have found four empirical studies on this topic.[2] These are summarized in table 1, with the variables used and the estimates of demand elasticities. Frey (1983) performed a national analysis, with states as the units of observation. Using six independent variables, he found that all variables had their hypothesized signs and estimated the price elasticity of demand to be between -0.4 and -2.1. Frey's work is based on statewide data with the explanatory variables associated with private schools averaged to obtain state-level data; thus, his work is unavoidably limited to highly aggregated variables and thus loses some of the flavor of local choice. West and Palsson also estimated a model with state-level variables. Using eight independent variables, they estimated the price elasticity to be from -1.5 to -3.0.

Hamilton and Macauley used school district-level data from New Jersey and applied the log transformation to the dependent variable, so it is not bounded at zero. They did not use a price variable in their study because they selected homogeneous school districts where the variance of private tuition was very low. They focussed special attention on the standard deviation of household income because, they argued, the variable is a proxy for the effect of student peer groups on achievement. Lankford and Wyckoff applied a logit analysis to a unique data set for 28,000 individual students in New York State. As summarized in table 1, the decision to attend a religious school was modeled as a function of income and tuition, plus five school characteristics, five environmental factors, and five demographic indicators.

Frey (1991) and Martinello and West introduce two important considerations for this analysis. First, a tuition tax credit might be expected to increase the tuition charged by private schools in situations where the supply of private education is not perfectly elastic. Second, a tax credit of the magnitude offered in policy proposals might be of such large magnitude that it might cause out-of- sample changes in private school enrollment.

Our paper most closely follows Hamilton and Macauley in explaining parental choice as a function of key characteristics without explicitly equating cost with quality. We also utilize a school district-level analysis that has substantial variation in both enrollment and in the explanatory variables, providing a wider range of latitude for policy simulation before running into out-of-sample problems. Our work extends theirs in that we are also able to include information on both private school costs and a performance-based indicator of student achievement as explanatory variables. We also have unusually wide variation in our tuition variable, which allows us to make inferences about the effect of fairly large tuition tax credits with somewhat more confidence than the narrower ranges used by other studies. We are thus able to present additional information on the price elasticity of private school enrollment and on the likely effect of tuition tax credits. Our results suggest that a tuition tax credit would have to be quite large, in the $2,000 to $3,000 range, before a significant increase in the proportion of students attending private

Table 1 Variables used in Previous Studies of Public and Private School Choice

Author(s)	Frey	West and Palsson	Hamilton and Macauley	Lankford and Wyckoff
Unit of Observation	50 States	50 States	New Jersey Districts	Individual NY Students
Dependent Variable	% Children in Private School	Log of Odds of Attending Private School	Log of % Children in Private School	0-1 Attend Religious School
Independent Variables	Per Capita Income	Per Capita Income	Per Capita Income	Household Income
	% Catholic	% Catholic	% Catholic	Whether or Not Catholic
		Racial Composition	Racial Composition	Degree of Urbanization
	Private Tuition	Private Tuition		Private Tuition
	% Private Schools with Title 1	Pupil / Teacher Ratio	Standard Deviation of Income	Ratio of Parents' Income to District Average
	Regional Dummies	Administrative Costs	Household Size	Pupil / Teacher Ratio
	Interaction of Tuition and Income	% Membership in NEA	% Household Heads with College	At Least One Parent with College Degree
		Length of Teacher Strikes	% Households Below Poverty	Proportion of Students with Above Average Test Scores
			School District Population	Proportion of Students to 4-Year Colleges
Estimated Price Elasticity	-0.4 to -2.1	-1.5 to -3.0	None Estimated	- 87 to -3.35

school would be experienced. In addition, we examine the effect of racial composition on school choice at the local level in a different regional context (Georgia versus the Northeast) and find that the results are quite different.

Determinants of School Choice

There are three important issues involved in specifying a model of school choice. The first is to choose a theoretical framework for explaining individual choice. The second is to link the theoretical framework for individual choice to the empirical specification appropriate for the degree of aggregation of the best available data. The third is to select the explanatory variables which capture the most important influences on that choice. We deal with these issues in turn.

Economic analysis of educational choice has been based on a model of utility maximization based on rational choice. The utility of the ith household if private education (subscripted by v) is selected is given by $U_{iv}(\mathbf{q}_v, c_v, \varepsilon_v)$ where $\mathbf{q}_v$ is a vector consisting of school characteristics, c_v is a composite of all other goods consumed, and ε_v is an error term. The utility associated with public education (subscripted by p) for the ith household is given by $U_{ip}(\mathbf{q}_p, c_p, \varepsilon_p)$. Parents evaluate whether the characteristics associated with private education ($\mathbf{q}_v$ and c_v) provide higher utility than the relevant public school alternative. The probability of any individual attending a particular educational alternative (say, a private school) is the expected value of a random variable P_i which takes on the value 1 if $U_{iv} > U_{ip}$ and 0 if $U_{iv} < U_{ip}$ Because of the presence of the error term, U_{iv} and U_{ip} are random variables. The dependent variable in our study is the proportion of children for whom the choice of private school attendance is made; this is given by $\pi_j = (\Sigma P_{vj})/N_j$, where N is the number of school age children and the subscript j denotes the school district. This random utility specification has been found to be generally appropriate for explaining individual school choice decisions (Lankford and Wyckoff).

As noted above, Frey (1991) argues that the supply side of private education must be modeled to avoid bias in the estimates of demand as

a function of tuition. We concur, but like many other researchers have not been able to develop adequate data to allow systems estimation. We follow the lead of other researchers (Hamilton and Macauley; Lankford and Wyckoff; West and Palsson) in modeling only the demand side of educational choice, implicitly assuming a perfectly elastic supply of private school places. Thus our study estimates the effect of tuition and other explanatory variables on parental demand for private education and not on the actual effect of tuition changes or tuition tax credits. To the extent that supply is not perfectly elastic, these demand estimates overstate the effect of tuition changes on private school enrollment.

A serious problem with our study, as well as the great majority of other research on this topic, is the problem of using aggregated data to model the effects of policy variables on individual choices. Our study is framed at the level of the school district, which captures more sample variation than studies utilizing statewide data (Frey; West and Palsson) but still does not reflect the actual unit of choice - the individual family. The most serious drawback is the lost variation in the sample; for example, average income levels will do an imperfect job of measuring how individual household incomes affect individual school choices at different points on the range of household incomes in the sample. Additionally, at an aggregate level there is a simultaneity between school choice and quality that is not present at the individual level (Lankford and Wyckoff). This arises from the effect on school quality of the aggregate choice of public versus private education - more students from families with parents who are politically influential and/or active in the public schools can be expected to improve school quality. More students from these households choosing private schools can be expected to decrease school quality. While family-level data would indeed be desirable, we feel that the district-level analysis employed here, like that of Hamilton and Macauley, provides enough disaggregation to give a good indication of the determinants of school choice.

Selection of the variables in **q**, the vector of school attributes, depends on the context of the study and the available data. School quality is obviously an important characteristic - higher quality public schools or lower quality private schools can be expected to decrease P_t. In this study we restrict ourselves to the former because of data limitations. As noted by Monk, there is no single best measure of school quality. One measure is students' test scores; the hypothesis is that better scores reflect higher school quality. Test scores can also reflect a student's household characteristics and other influences as well as school quality; nonetheless it remains a favored explanatory variable of educational researchers.[3] The school district's average score for the tenth-grade criterion reference test of reading ability is used to measure the educational quality of public schools. We expect that higher test scores will make public schools more attractive and thus decrease private school enrollment.

Expenditure on education has also been used as a proxy for school quality; the hypothesis is that higher expenditures result in better education. Although Monk has pointed out the difficulties of equating expenditure with quality, many studies have used expenditure measures. Therefore, we use the school district's total per-pupil expenditures. The student/teacher ratio is another commonly accepted indicator of quality; lower ratios might be expected to indicate more individual attention and thus better education. The data for these three public school district variables were for 1990 and were obtained from the Georgia Department of Education.

Another characteristic we examine is the percentage of African-American school age population by school district. In much of the South, including rural areas, private education boomed in the 1960's as the integration of public schools mandated by Brown versus Topeka Board of Education was implemented. We include the racial composition variable to investigate the effects of racial composition on school choice.

The variables which indirectly determine the household's non-public education consumption are family income and the cost of private education. Higher levels of income can be expected to increase the probability of sending a child to private school, while higher private school tuition charges should decrease that probability. Since the financing of public education is separate from individual choices to send children to public or private schools, the

individual's marginal cost of sending a child to public school is zero.

The Data

The unit of observation is the school district. In 1990, Georgia had 159 county school systems and 27 independent city school systems. Since most of the variables are measured at the county rather than the city level, it was necessary to delete from the observation set those counties that had coexisting county and city school systems. Deleting these observations left a total of 136 counties that had a single public school system, and in these counties the school district boundaries coincide perfectly with the county boundaries. Of these counties, 105 met the U.S. Census definition of a nonmetropolitan county; these observations form the basis of our analysis.

All data except private school tuition and the three school quality measures previously noted are from the 1990 Census. The dependent variable is the ratio of children residing in a school district that attend any private school to the total number of children attending any school. The income variable is per capita income in the school district; the racial composition variable is the total percentage of African-Americans in the school-age population in the school district.

Data on the tuition charged by private schools were obtained by a telephone survey. The basis for the survey was a compilation of the state's 454 private schools by the Georgia Department of Education. The compilation lists each private school's enrollment and the grades taught, and it contains the full range of private schools, from high schools with over 1,000 students to church-based elementary schools with five pupils. Tuition at a private school is lowest for first graders and most expensive for high schoolers.

Typically, a county would have one large private school teaching all grades, and several small elementary schools affiliated with churches. Information on boarding schools (of which there are only seven in Georgia) was not used. Schools offering only primary education were much smaller and represented a low proportion of our sample's private school enrolment, 31.5 percent. The combination of this small percentage and the expense and difficulty of gathering data from these establishments led to our omitting these schools' data from the construction of our tuition variable. Some counties had no private high school but had one or more private elementary schools, and these were usually church- supported. In these cases the tuition from the elementary schools was not used, but rather the high school tuition from a neighboring county.[4] For these reasons we believe that high school tuition is the best indicator available to us of the private school price for most parents considering private schools for their children.

A weighted average of tuition was calculated for the counties with two or more private high schools. Counties that had no private school were assigned the tuition of its lowest-tuition neighboring county, plus the annual transportation costs (assumed to be by automobile) from the center of that county to border of the neighboring county. Transportation mileage was calculated as the distance, measured on a road map, times two times 180 school days. Transportation costs were calculated by the annual travel milage times the per mile travel cost, which will depend on an array of factors including fuel costs, vehicle value and the opportunity cost of travel time. Travel costs of $0.35 per mile were selected primarily because it seemed a reasonable figure. Alternative travel costs of $0.25 and $0.45 were pretested in the empirical model but they did not affect the tuition variable's performance substantially. As noted above, the travel costs were added to the annual private school tuition. Thus regions of the state that have no private schools will reflect that absence by having relatively higher private tuition costs.

Estimation and Results

Our dependent variable is a proportion, and each observation actually represents the sum of individual choices by underlying populations of varying size. OLS estimates will therefore suffer from problems of heteroskedasticity, and will be inefficient (although unbiased). We chose to use weighted least squares estimates corrected for heteroskedasticity. This approach is appropriate for our data and performs as well as any available alternatives. In addition, it presents no problem for observations close to zero (Greene). The dependent variable is the log odds of private school attendance

$\ln [\pi_j / (1 - \pi_j)]$, where π_j is the aforementioned proportion of children in private school. The weights are provided by a consistent estimator of variance of the heteroskedastic errors:

$$s_j^2 = N_j \pi_j (1 - \pi_j)^{-1}. \quad (1)$$

The estimated equation takes the form:

$$s_j^{-1} \ln[\pi_j / (1 - \pi_j)] =$$

$$s_j^{-1} \alpha + \beta (s_j^{-1} \mathbf{X}_j) + u_j. \quad (2)$$

We were particularly interested in the effect of the tuition variable, and expected that it might be nonlinear. In particular, we hypothesized that tuition differences would matter more at low tuition levels but would have less effect at very high tuition levels as the odds of attending private school became very low. To test this, we examined a scatter diagram of proportion of private school attendance and tuition and found a curvilinear, inverse relationship. Therefore, we used a squared tuition term to provide more flexibility for the model. The model performed well (table 2), with significance at the 0.05 level for the variables of the most interest to our study. Only the input measures of school quality-teacher-student ratio and per-student expenditure - were not significant at the 0.05 level, although the latter was at the 0.10 level.[5]

We first turn to a comparison of the price elasticities for private education. For this study, as well as the previous ones, interpreting an elasticity is awkward because the dependent variable is the log of a proportion and a quadratic term is included. We therefore utilized a standard numerical approximation for the point elasticity: [[f(P+h)-f(P)]/h] / [f(P)/P], where h is a small increment in tuition, $1, and P is the average tuition. Applying this approximation leads to a price elasticity of -1.07. This is on the lower end of the elasticities found by other researchers (see table 1).

Of these existing studies, only Lankford and Wyckoff use the estimated model to simulate the effects of public interventions which change the effective price of private education. They present an experiment which predicts the change in private school enrollment if tuition were effectively reduced to zero. They find that such a policy would double enrollments in their sample from 12 percent to 25 percent. We choose to examine the effect of more modest public subsidies to private education as being more likely to approximate any actual policy relevant to rural Georgia in the foreseeable future.

We use the estimated parameters of Equation 2 to simulate the effect of vouchers or tax credits for private education. If people view these policies as a dollar-for-dollar private school tuition reduction, then we can project a credit's effect by substituting a new tuition value reflecting the subsidy and then calculating the resulting $\hat{y}$. The average private school tuition in our sample is $3605 per year. A $500 tuition tax credit (or voucher) would increase the demand for private school education by 0.61 percent of the total student population. This represents a small decrease in public school attendance - about 16 students in the average rural Georgia county - but a fairly significant increase in enrollment for private school given the relatively low current enrollment percentages.

A $1,000 credit would cause demand for private education to rise by 1.32 percent of the total enrollment, but would represent a 35 percent increase in the demand for private school places. A $2,000 credit would increase demand by 3.1 percent of the total student population; this would increase private school demand by more than half and cause a noticeable though not significant reduction in public school attendance if the supply of private school places were elastic enough to absorb these students without significant tuition increases. A $2,600 voucher - the amount contained in California's Proposition 174, which was narrowly defeated in November, 1993 - would increase private school enrollment by 4.4 percent of the total student population and more than double demand for private school places in the average Georgia rural school district.

The effect of per capita income is as expected (and the coefficient is significantly different from zero); wealthier populations send a higher percentage of students to private schools. Our proxy for student achievement in the public schools was also significant and negative: higher test scores apparently result in higher public enrollment (although there is the possibility of some

Table 2. A Weighted Least Squares with Heteroskedasticity Correction Model of the Demand for Private Education, Georgia School Districts, 1990. (dependent variable: log odds of private school attendance in a school district)

Variable	Mean[a] (std. dev.)	Range[a]	Coefficient (std. err.)
Tuition, Adjusted for Travel Costs	3605 (2099)	1445-12608	-0.0003 (0 0001)*
Square Tuition			2.22 E-08 (7.48 E-09)*
Per Capita Income	9599 (1251)	6991-14055	0.0002 (0.0001)*
Per Cent African-American Population	38.5 (20.9)	01.0-91.1	0 0290 (0.0043)*
Standardized Test Score	654 (8)	637-670	-0.0269 (0 0077)*
Pupil - Teacher Ratio	15 2 (1.5)	5.4-19 0	0.0392 (0.0391)
Per-Pupil Expenditure	3446 (291)	2778-4512	0.0003 (0.0002)**
Intercept			10.8261 (5 2144)*
Number of Observations			105
Adjusted R-squared			0.978

[a] These descriptive statistics are for the untransformed independent variables. The regression coefficients refer to the transformed variables as defined in equation (2).

* indicates rejection of the one-tailed hypothesis test at the 0 05 significance level

** indicates rejection of the one-tailed hypothesis test at the 0.10 significance level

simultaneity here if students with higher demand for education are most likely to leave public schools). The coefficient for the school expenditure variable was positive and significant at the 10 percent level.

It is surprising that higher public school expenditures seem to be associated with higher private school enrollments, but this result was also reported by Lankford and Wyckoff. They offer the explanation that school quality is better explained by test scores and student-teacher ratios, and expenditures mainly reflect cost differences. Another explanation is that additional private school attendance increases public school per-pupil expenditure ceteris paribus because funding drops proportionally less than enrollment. The coefficient for student-teacher ratio was not significant; this could well be a result of high degrees of collinearity with the two variables discussed above. Overall, the evidence of our model supports the view that higher quality public schools decrease the likelihood of any given student's enrollment in a private school.

The coefficient on the racial composition variable is positive and significant at the 5 percent level; higher percentages of African-American students in the school age population are associated with higher private school enrollments. At the mean the point elasticity is 3.76; these changes appear to be fairly large. It is certainly possible that this variable is picking up perceived quality or income effects not captured by the variables we used to measure these factors. However, overall we believe that this result supports the view that the decision to attend private school in rural Georgia is still partially explained by segregationist preferences.

Summary and Conclusions

We present a model of school choice in rural Georgia. The model performs well and indicates that private school enrollment is influenced by private school tuition, but not to the extent found in studies in other parts of the country. Our results indicate that tuition tax credits or voucher policies which significantly lower the cost of private education in Georgia will have a significant effect on the demand for private education but a relatively small effect on public school enrollments. A primary result will be a subsidy to parents who are already sending their children to private schools.

The results indicate that rural public education administrators can potentially influence parents' decisions to remove their children from public schools. We find that school quality, as measured by achievement test scores and teacher/student ratios, does significantly influence school choice. Higher quality public schools are associated with lower percentages of children attending private school. Thus, administrators who achieve higher quality education in their classrooms can expect to be rewarded with fewer students leaving the public schools.

Unsurprisingly, the results indicate that counties with higher incomes tend to have higher rates of private school attendance. On the other hand, school districts with higher proportions of African- American students experience a lower proportion of students in the public schools. This evidence supports the view that segregationist attitudes in Georgia lead to increased private school attendance.

One contribution of this study is its disaggregation; school district-level data can capture more variation than statewide studies. We believe that it is important to extend the study of school choice to an even more disaggregated level: to the household itself or, failing that, to the level of the census tract. We also believe that a fuller understanding of choice behavior will require measures of private school quality; these differences should be just as important as differences in public school characteristics. Finally, a full understanding of the effect of tax credits and vouchers on private school enrollment will require an understanding of the response of the supply of private school places to demand shifts.

References

Anderson, J. and M. Binstein. "Jersey City: Lab for School Choice." Washington Post, September 26, 1993.

Asimov, N. "How Vouchers Work in Milwaukee." San Francisco Chronicle September 27, 1993.

Banks, S. "School Voucher Initiative in California Narrowly Trails, 45% - 39%." Los Angeles Times, September 16, 1993.

Bingham, J. "1/2 Tuition for Low-Income Families." Denver Post, June 2, 1993.

Darling-Hammond, L. Kirby, S, and Schlegel, P. Tuition Tax Deductions and Parent School Choice: A Case Study of Minnesota. Santa Monica, CA: Rand Corp, 1985.

Flowers, M. "Tuition Tax Credits and the Public Schools." Nat. Tax J. 41(1988): 87-96.

Fox, W. "Reviewing Economies of Size in Education." J. Ed. Fin. 26(1981): 273-296.

Frey, D. Tuition Tax Credits for Private Education. Ames: Iowa State University Press, 1983.

Frey, D. "Tuition Tax Credits for Private Education." Pub. Fin. Quart. 19(1991): 347-354.

Greene, W. Econometric Analysis (2nd ed.). New York: Macmillan, 1993.

Hamilton, B. and Macauley, M. "Determinants and Consequences of the Private-Public School Choice." J. Urban Econ. 29(1991): 282-294.

Lankford, H. and Wyckoff, J. "Primary and Secondary School Choice Among Public and Religious Alternatives." Econ. Ed. Rev. 11(1992): 317-337.

Leff, L. "Schaefer Wins Round in School Vouchers." Washington Post, February 6, 1993.

Martinello, F. and West, E. "Education Budget Reductions via Tax Credits: Some Further Considerations." Pub. Fin. Quart. 19(1991): 355-368.

Monk, D. Educational Finance: An Economic Approach. New York: McGraw-Hill, 1990.

Stiglitz, J. "The Demand for Education in Public and Private School Systems," J. Pub. Econ. 3(1974): 349-385.

Wall Street Journal. "Choice Goes National" (editorial). October 7, 1993.

West, E. and Palsson, H. "Parental Choice of School Characteristics: Estimation Using State-Wide Data." Econ. Inquiry. 26(1988): 725-740.

Endnotes

1. Early proposals included a $250 - $500 credit considered by the U.S. Senate in 1981 (Frey 1983). Proposals for tax credits from $1,000 to $2,600 have been made or considered at a national level (Wall Street Journal), at the state level by voter initiative in California (Banks) and by legislative proposal in Colorado (Bingham) and Maryland (Leff). Local experiments with vouchers include Milwaukee (Asimov), Jersey City (Anderson and Binstein), and Denver (Bingham).

2. Another empirical study (Darling-Hammond, *et al.*) has examined the effect of tuition tax deductions.

3. Fox notes (p. 281) "Achievement test scores are the output quality proxy generally used."

4. Comparing private school enrollments for these small primary schools with census data on private school enrollment for county residents indicated that the substantial majority of students in these counties were attending schools in other counties.

5. The adjusted R^2 for this model was 0.98, but the R^2 is a poor indicator of model performance for this model (Greene).