ASSESSING THE TECHNICAL EFFICIENCY OF PUBLIC HIGH SCHOOLS IN THE STATE OF GEORGIA

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ABSTRACT

This study analyzes public high school efficiency, defined as the maximum level of educational attainment obtained with a given level of school inputs, in the State of Georgia. Using data envelopment analysis (DEA), urban and rural public high school efficiency differences are evaluated using a two-step estimation process. First, a nonparametric Mann-Whitney U-test confirms the significant difference in mean efficiency scores between urban and rural high schools. Second, we use a Tobit regression model to find factors that influence the efficiency differences between rural and urban high schools. The regression results suggest that rural schools operate less efficiently than urban schools.

Keywords: *Educational Achievement, Technical Efficiency, DEA Analysis, Tobit Regression*

1. INTRODUCTION

The public school literature seems to have two dominating policy concerns. First, from an international perspective, federal legislation (e.g. the No Child Left Behind Act of 2001), which introduces accountability measures coupled with public school choice requirements, seems to originate due to the seeming disparities in the quality of U.S. public schools relative to those in other countries. At a national level, education is an important tool that countries use to develop human resources and increase their global competitiveness (OECD, 2001). Saito and McIntosh (2003) point out that performance on standardized tests began a steady decline in the U.S. in 1963 [and leveled off in 1979 – see Jeon and Shields (2005)] while graduation rates changed very little. This suggests that the quality of U.S. high school graduates has declined. Despite the fact that education costs and the quality of education inputs have increased, public opinion is that educational inputs explain little about educational quality. This finding is confirmed by Hanushek (1986), who says "there appears to be no strong or systematic relationship between school expenditures and student performance" (p. 1162).

From a regional perspective, a second policy concern exists: the disparity between the education quality provided by urban schools and rural schools. Although the distinction between "urban" and "rural" schools is often blurred, with school systems often having both urban and rural characteristics, policymakers and regional scientists continue to use this distinction. For example, Kantabutra and Tang (2006) use data on upper secondary schools in Thailand to argue that "policy to improve school efficiency should thus focus on rural schools, expanding school size while reducing class size" (p. 355). One way to have more fruitful dialogue about education quality differences based on an urban/rural distinction is to have multiple categories that account for a continuum of characteristics that make an area "more rural" or "more urban". The Economic Research Service, part of the U.S. Department of Agriculture (ERS-USDA), publishes an urban-rural continuum that may be used to more accurately handle areas that truly do not fit the singular 'urban' or 'rural' distinctions.

Urban and rural schools (or school systems depending on the unit of analysis) can be classified as efficient or inefficient. Generally, economists discuss Pareto efficiency, which is attained if any decision-making unit (DMU) cannot alter any of its inputs or outputs without worsening some of its other inputs or outputs. Since the theoretical ly possible levels of efficiency are never known fully in the social sciences, economists commonly discuss efficiency in relative terms. Using the definition offered by

Cooper, Seiford, and Zhu (2004), a "DMU is rated as fully (100%) efficient on the basis of available evidence if and only if the performances of other DMUs does not show that some of its inputs or outputs can be improved without worsening some of its other inputs or outputs" (Chapter 1, p. 3).

A number of studies have estimated the school efficiency by using different efficiency models to measure school performance. The study by Taylor (1994) suggests that approximately 15 percent of U.S. schools are inefficient; this has significant ramifications for a country's total output. For example, Bishop (1989) estimated that decreases in national test scores in the U.S. in the 1970s had a negative impact on labor quality (measured using productivity growth during those years), which decreased Gross National Product (GNP) by $86 billion.

Mancebon and Bandres (1999), who use data on 3,189 students to evaluate the efficiency of 35 public-sector secondary schools in Spain, question those studies that have concentrated on measurement methodology "to the detriment of a discussion about whether or not this methodology is appropriate for the task..." (p. 131). The authors state that "This situation...has given rise...to the construction of measurement models that are hard to justify from a conceptual point of view, given that they are constructed essentially in function of available data, and whose main objective...is to illustrate the most appropriate mathematical treatment in each case" (p.131).

The conceptual model in this paper is straightforward – estimate the impact of a series of education-related inputs on education system output. Data on all public high schools in Georgia are analyzed within a stochastic frontier framework to determine which public high schools are relatively more efficient at producing a certain graduation outcome. Given the number of multiple outputs and inputs and usage of a disaggregated data set, this study will examine the issue of public high school efficiency in Georgia. First, a brief summary of the data envelopment analysis (DEA) methodology is given. Second, the data used to estimate relative efficiency are described. Third, the technical efficiency of Georgia public high schools is determined. Fourth, these technical efficiency scores are utilized as the dependent variable in a Tobit regression framework. Finally, we discuss implications, policy prescriptions, and future research needs.

2. DATA ENVELOPMENT ANALYSIS (DEA) METHODOLOGY

Data Envelopment Analysis (DEA) is a linear programming (LP) technique for measuring the relative efficiency of a set of homogenous decision-making units (DMUs) where the presence of multiple inputs and outputs makes comparisons difficult (Charnes *et al.*, 1978). DEA uses the data from all DMUs (e.g. schools) to construct a "best production frontier" that envelopes the data and simultaneously calculates the distance to that frontier for the unit. DEA assesses the performance of the DMU relative to the production frontier. Being above or below the production frontier is due to inefficiency.

In this study, public school districts are modelled as multiple inputs and multiple outputs DMUs. It is hypothesized that each school maximizes multiple outputs (e.g. graduation rate) given the available inputs (e.g. student/teacher ratio). As such, the model utilizes an "output-oriented approach". The approach obtains the best possible outcome based on the given available resources rather than minimizing cost of these resources (Mancebon and Bandres, 1999). The technical efficiency of each school district is measured by obtaining maximum possible outputs for the same level of inputs.

Numerous studies in the literature utilize the output-oriented approach for assessing school technical efficiency (see Denaux, 2009; Rassouli-Currier, 2007; Primont and Domazlicky, 2006; Kantabutra and Tang, 2006; Mante and O'Brien, 2000; Mancebon and Bandres, 1999; and McCarty and Yaisawarng, 1993). Assuming there are n=1,...,N school districts, each school district produces p=1,...,P outputs using inputs that are directly controlled by a school district's control where: y_n is a $p \times 1$ vector of quantities of output produced by school n; Y is a (P x N) matrix of P different outputs used by N different school districts; x_n is the vector of different inputs for school n; X is a (M x N) matrix of M different inputs used by N different school districts; and v_n is the intensity vector of the weights attached to the n schools for the construction of the virtual comparison unit for schools n. The technical efficiency of the n schools is assessed by solving n LP models. The vectors y_n and x_n are adapted each time for the school n considered. Then the following DEA model is used to measure the output-oriented technical efficiency of each school district:

Maximize	Eff_{pxp}	[1a]
subject to	$Eff_{pxp}\ y_{px1} \le Y_{pxn} v_{nx1}$	[1b]
	$X_{mxn} v_{nx1} \le x_{mx1}$	[1c]
	$\sum_{j=1}^{n} v_j = 1$	[1d]
	$v_j \ge 0,\ j = 1,\ldots,n$	[1e]

Where, *Eff* is the measure of technical efficiency of each school district.

The LP problem assumes variable returns to scale (VRS). The other alternative scale property is constant returns to scale (CRS), which is modeled by adding the constraint $\sum v_j \ge 1$. The two models are nested in the sense that frontier CRS $\subset$ frontier VRS. The calculated technical efficiency scores for the VRS specification will be higher than results of the CRS specification. Even though the VRS specification is commonly used when research focuses on the education sector, the school efficiency scores under the CRS specification are calculated to determine whether the technical efficiency scores are sensitive to any scale assumptions.

DEA uses the distance to the frontier as a measure of efficiency. Differences in the distance to the frontier provide a score for each school greater or equal to 1, where 1 stands for best performance located on the frontier (a DMU is efficient). A score greater than 1 indicates inefficiency (worst performance). For example, a school efficiency score of 1.9 implies that the school in question is inefficient. So, a school district could increase its efficiency by 0.9 or 90 percent (1.9-1) without changing its current input usage. Figure 1 illustrates the DEA technique

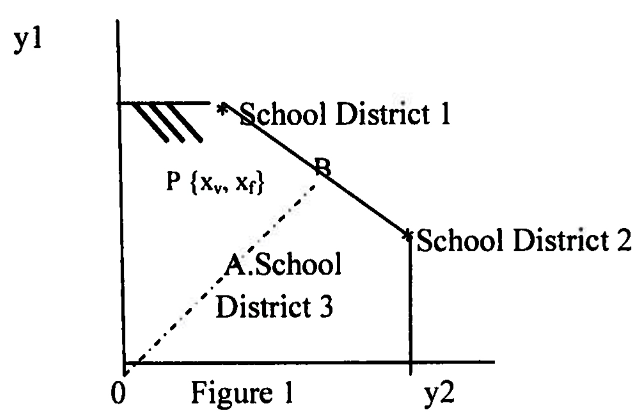

Figure 1

where x_v and x_f are a vector of input quantities that are beyond and under the district's control, respectively. Figure 1 is an example of the two-output bundles (y1 and y2) of three school districts. Each school uses same level of two inputs (x_v and x_f) to maximize the outputs (y1 and y2). School District 1 and 2 lie on the frontier suggesting that both districts produce maximum outputs from a given set of inputs. They have the "best practice frontier of the technology." School District 3 lies inside the frontier. The

distance 0B/0A tells us how far school district's observed output bundle deviates from the best practice frontier of production possibilities set. Since the distance 0B/0A is greater than 1, School District 3 is inefficient.

In this research, both city and county public high schools in the State of Georgia represent the DMUs. Georgia was selected for several reasons: it contains nearly 400,000 students who attend rural schools; education attainment among rural adults is among the lowest in the U.S.; it ranks 12^{th} overall in the U.S. in terms of four education measures (importance, poverty, challenges, and policy outcomes); and minority enrollment in rural areas is relatively high (Johnson and Strange, 2005). The higher a state's ranking, the more urgent is the need for policy remediation.

3. DATA FOR EFFICIENCY ANALYSIS

The data are obtained from the Georgia Department of Education and the State Education Data Center[1]. The data include 180 school districts in Georgia for the 2006-2007 academic year. Using data only for public high schools, our sample size is 326.

As outputs from the educational process, two variables - the high school graduation rate (Gradrt) and the average SAT score of the graduating class (Satsc) - are used as proxies to measure each high school's efficiency (educational achievement). The selection of these variables follows the study by Kantabutra and Tang (2006). The high school graduation rate (Gradrt) is measured as the percentage of the 2007 class graduating with some kind of diploma, including college-preparatory and vocational studies. The SAT is a standardized college admission test in the United States. Including two output variables allows for some latitude in defining the "best performance" schools; some schools may have a higher percentage of high school graduates with low SAT scores whereas other schools may have a low percentage of high school graduates with high SAT scores (Kantabutra and Tang, 2006; Denaux 2009).

Broad spectrums of discretionary inputs (under a district's control) are used to calculate schools' educational efficiency scores. The student-to-teacher ratio (Str), average years of teaching experience (Exp), percentage of teachers with an advanced degree (Adv), and the number of students for which English is a second language (Sed) are included to capture the school environment. Student/teacher ratio is the number of students relative to the number of full-time equivalent professionals assigned to that school. Student-teacher ratios represent an estimate of average class size so that smaller class size is expected to improve the students' performances. The average years of teaching experience (Exp) is the sum of all the years of the faculty's professional teaching experience (in years) divided by the number of faculty members. The percentage of teachers with an advanced degree (Adv) captures those professionals who have earned post-baccalaureate degrees (e.g. master's, specialist, or doctoral degrees). The average years of teaching experience and the percentage of teachers with an advanced degree are assumed to be important factors in determining teaching effectiveness and have a hypothesized positive impact on student academic performance.

Following the study by McCarty and Yaisawarng (1993), this study also considers an input, the percentage of economically disadvantaged students enrolled (Econdis) that is non-discretionary (beyond the districts' control) factor to capture the socioeconomic background of the student. An "economically disadvantaged" student is a student who comes from a household that meets the income eligibility guidelines for free or reduced-price meals (less than or equal to 185% of Federal Poverty Guidelines) under the National School Lunch Program (NSLP). Students from low income families are hypothesized to achieve less academically in school. So, the academic climate at home positively affects a student's achievement and is highly determining the educational outcomes (Waldo, 2006).

According to the Office of Management and Budget, a Metropolitan Statistical Area (MSA) is an area consisting of a recognized nucleus and adjacent communities that have a high degree of integration with that nucleus. In this study we define a school as being "rural" if it is not located in a Metropolitan Statistical Area (MSA). While this is not a perfect measure of rurality, it does provide more of a distinction to Georgia's counties for analysis purposes. Given the relatively large number of counties in Georgia (second only to Texas in the number of counties), we think this distinction is important from a policy perspective. The sample comprises 223 public high schools in Georgia MSAs and 103 public high schools in non-MSA counties. Table 1 summarizes the descriptive statistics of the variables used in the efficiency analysis.

TABLE 1. DESCRIPTIVE STATISTICS OF THE VARIABLES USED IN THE EFFICIENCY ANALYSIS

	MSA 223 Observations				Non-MSA 103 Observations			
Variables	Mean	Std	Min	Max	Mean	Std	Min	Max
Outputs:								
Gradrt	73.69	11.95	35.00	100	70.34	10.33	42.90	100.00
Satsc	1419.12	124.56	1119.00	1702.00	1378.48	100.57	1104.00	1659.00
Inputs								
Str	15.83	1.61	10.60	20.90	14.85	1.48	11.40	18.60
Exp	12.73	2.19	7.20	18.80	14.47	2.03	8.90	18.70
Adv:	59.07	7.99	33.30	87.50	60.85	10.75	31.20	87.10
Sed:	2.85	4.86	0.00	45.10	1.14	1.83	0	12.90
Exppupil[1]	7868.57	1009.19	743.00	11324.00	7897.40	1120.25	273.00	12051.00
Econdis:	39.47	21.12	1.70	100.00	57.66	23.11	14.50	100.00

1) Source of the data is www.schooldatadirect.org;

4. RESULTS OF EFFICIENCY ANALYSIS

The efficiency score for each school is estimated using the DEA technique, which solves an output-oriented linear programming model, using the OnFront software (Fare and Grosskopf, 2000). The results for the CRS and VRS model specifications, using all schools as the reference base, are given in Table 2.

TABLE 2. EFFICIENCY RESULTS

	MSA				Non-MSA			
Output Oriented Technical Efficiency of schools	Mean	Std	Min	Max	Mean	Std	Min	Max
• **CRS**	1.15	0.12	1.00	1.50	1.20	0.13	1.00	1.60
• **VRS**	1.12	0.10	1.00	1.43	1.15	0.10	1.00	1.43

On average, the public high schools located in the urban counties (MSA) have lower technical efficiency scores ranging from 1.12 to 1.15 depending on the scale assumption (CRS or VRS). The associated standard deviations are considerable (0.10 to 0.12). The main implication of this result is that (regardless of scale assumption) the non-MSA schools appear to be less productive than those in MSA areas. More specifically, non-MSA public high schools may be able to increase their educational efficiency by 20 percent (1.20 - 1) and 15 percent (1.15 - 1) without consuming additional inputs. Public high schools located in MSA counties may be able to increase their efficiency level by 15 percent and 12 percent, respectively. This finding is consistent with the studies by Kantabutra and Tang (2006) and Denaux (2009).

A nonparametric Mann-Whitney U-test (two-sided) is used to determine whether the differences in mean efficiency scores between MSA and Non-MSA high schools in the state of Georgia are significant. The average urban high school efficiency scores differ significantly from the average rural high school efficiency scores at the 1 percent significance level regardless of the chosen scale assumption (test statistic of 36.62 and p-value = 0.0001 for separate efficiency score). This finding suggests that efficiency scores between MSA and non-MSA high schools are different and that rural schools (Non-MSA) are producing less output (lower graduation rates and lower average SAT scores) than urban schools (MSA) in the state of Georgia.

At the individual school level, almost one-fifth of high schools located in a MSA are operating at or near full efficiency. This implies that no other high school is more efficient in producing the maximum possible outputs using the same level of inputs. Using the VRS specification, 67 out of 326 schools (20 percent) are fully efficient. Expectedly, 49 of the 67 VRS-efficient schools are located in MSAs. However, surprisingly, a total of 48 high schools (14 percent) have efficiency scores of 1.20 or higher, all of which are located in MSAs. By contrast, only 26 (8 percent) high schools located in the non-MSA counties have efficiency scores of 1.20 or higher. So, we observe a larger percentage of relatively efficient schools in MSAs.

5. FACTORS AFFECTING SCHOOL EFFICIENCY: THE TOBIT REGRESSION MODEL

Several factors may impact the efficiency of individual public high schools. Some of these factors are neither inputs nor outputs in the education production process, but rather circumstances faced by a particular school. The objective of the second step of the empirical analysis is to identify the characteristics commonly found in the most efficient public high schools.

The estimated DEA efficiency scores (using the VRS specification) have a lower bound of 1.00 (best practice school), which needs to be taken into account in the estimation step. A common approach utilized here is to specify a censored regression model after transforming the DEA efficiency scores into *inefficiency* scores by simply subtracting 1.00 from each school efficiency score (Kantabutra and Tang, 2006). Then, transformed values are used as dependent variables in a Tobit regression model

$$y_i^* = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij} + u_i \qquad u_i \sim \mathrm{IN}(0, \sigma^2), \qquad [2]$$

where y_i^* is a latent variable representing the inefficiency of school *i*; x_{ij} are independent variables *j* (*j=1…,k*) for school *i*; and u_i is a disturbance term. Denoting y_i as the observed dependent variable, $y_i = 0$ if $y_i^* < 0$; $y_i = y_i^*$ if $y_i^* \geq 0$. Notice that the researcher must be careful when interpreting the results due to the construction of y_i^*.

Several non-discretionary control variables are hypothesized to impact school efficiency scores, including educational policy, community environment, and school characteristics. A binary variable is used to indicate if a school met "adequate yearly progress" (Ayp), where Ayp = 1 denotes met AYP standards for that school, 0 otherwise. Adequate Yearly Progress, a federal requirement under No Child Left Behind (NCLB), is an annual check to determine whether a school is achieving the targeted school goals for student performance in reading and mathematics. In order to receive federal funds under NCLB, schools must identify themselves as "needs improvement". Under federal law, if schools fail to meet AYP standards in two consecutive years, students have the option to transfer to a higher performance school in their district. Therefore, schools that meet the AYP requirements are expected to have higher graduation rates than other schools. In addition, the percent of high school graduates that are HOPE scholarship eligible is also included to capture the school academic achievement. Helping Outstanding Pupils Educationally (HOPE) is Georgia's scholarship and grant program that is funded entirely by the

Georgia Lottery for Education. The HOPE program rewards students with financial assistance in degree, diploma, and certificate programs. We hypothesize that schools with a higher percentage of students awarded a HOPE scholarship will have higher levels of school efficiency.

To capture community demographics of school districts, the percentage of adults residing within the school district with at least a high school diploma (Awhs), the percentage of adults residing within the school district with at least a bachelor's degree (Awba), and the percentage of residents who recognize their race as "White, non-Hispanic" (Wtnhis) are included. These measures are related to the availability of human capital in the school district. The educational attainment of parents can play a significant factor in influencing student academic achievement. Districts with more human capital are expected to have higher levels of school efficiency, both as a result of better qualified workers in the schools (teachers, staff) and parents who are more able to help their children learn. The income per capita by county (Incomeper) is also included for capturing the income variation among the counties. It is expected that lower income per capita counties have lower levels of school efficiency. Schools that reside in poorer counties suffer by not having sufficient fiscal capacity (tax revenue) to hire qualified teachers and purchase materials that are crucial to students' academic achievement. The unemployment rate (Urt), a nondiscretionary variable, is the percentage of the labor force that is not employed. Urt provides important information to assess the economic environment of the county in which the school is located and needs to be taken into account when efficiency is in question.

State and local expenditures per pupil (Exppupil) for each school district is included as a non-discretionary input. However, most existing studies treat this variable as a discretionary input and include it in calculating of technical efficiency scores (McCarty and Yaisawarng, 1993). Since data on state and local expenditures per pupil (Exppupil) are available by each school district, instead of by each high school, this research treats the variable as non-discretionary. The high levels of expenditure per pupil are more likely associated with better schools programs, low pupil teacher ratios, more qualified teachers, modern supplies and equipment, etc. Therefore, the schools that have higher state and local expenditures per pupil are expected to yield higher efficiency scores.

To distinguish public high schools located in "urban" (MSA) counties from those located in "rural" (Non-MSA) counties, a binary variable (Msa) is included into the regression analysis (high schools are urban if Msa = 1; high schools are rural if Msa = 0). The other binary variable included is County, which captures whether or not a high school is located in the city proper (County = 0) or the unincorporated county (County = 1). We include this measure to account for another layer of "urbanity" that may influence students' graduation outcomes. Also, to prevent the double-counting of some adults with a high school degree who also earned a bachelor's degree, we use Awhs and Awba as our measures of the general education level in a county in separate regression models to avoid the introduction of multicollinearity into the Tobit estimation. Table 3 lists the variables used in the regression analysis with summary statistics for the 326 observations.

TABLE 3. DESCRIPTIVE STATISTICS OF THE VARIABLES USED IN THE TOBIT ANALYSIS

	MSA (223 observations)				Non-MSA (103 observations)			
Variables	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
Hope[1]: The percentage of students that are HOPE scholarship eligible	36.70	12.50	5.70	71.40	34.90	11.50	7.40	84.60
Awhs[2]: The estimated percentage of adults residing in the county school district with at least a high school's degree	82.50	7.70	59.90	95.20	72.20	5.60	61.00	91.50
Awba[2]: The estimated percentage of adults residing in the county school district with at least a bachelor's degree	25.60	12.50	6.00	52.10	14.10	7.30	6.10	60.30
WtnHis[2]: Percentage of people residing in the county who recognize their race as "white" but not "Spanish/Hispanic/Latino."	49.10	30.20	0.00	99.60	53.10	25.10	0.70	98.90
Incomeper[3]: real income per capita by each county	31895	8001	19171	51476	24276	4279	5591	33409
Ayp[2]: Did the high school make Adequate Yearly Progress during the 2006-2007 academic year?	0.61	0.48	0.00	1.00	0.46	0.50	0.00	1.00
Urt: Unemployment Rate	4.64	0.78	3.10	6.70	5.25	0.98	3.60	8.50
Exppupil[1]: Federal, State and Local contribution per pupil expenditure at the school district level	7868	1009	743	11324	7987	1120	273	12051

Notes: 1) The data are from the Georgia Student Finance Commission website (http://www.gsfc.org/main/publishing/pdf/2007/gpa_by_school.pdf) 2) Source of the data is www.schooldatadirect.org; 3) The data are from the Georgia Statistics System (www.georgiastats.uga.edu).

6. RESULTS OF TOBIT ANALYSIS

Regression estimates in Table 4 indicate several important points. First, while the Tobit estimates have the same sign as the marginal effects, the marginal effects are consistently less in absolute magnitude than the Tobit coefficients. Second, the calculated marginal effects are used to measure the impact of each independent variable on school efficiency score. Finally, since the dependent variable is defined as 1 minus the VRS efficiency score, the transformed efficiency scores used in the Tobit estimation are interpreted as *inefficiency* scores. This means the sign of each independent variable is inversely correlated with school *efficiency*. A negative coefficient, for example, suggests that there is a positive relationship between the independent variable and the school efficiency score.

TABLE 4. REGRESSION ESTIMATES (DV = DEA VRS INEFFICIENCY SCORES)

	Tobit Regression Using 'Awba'		Tobit Regression Using 'Awhs'	
	Estimates	Elasticities	Estimates	Elasticities
Constant	0.288*** (T = 3.84)		0.441***(T = 4.41)	
Msa	-0.001(T = -0.14)	-0.016	0.008(T = 0.57)	0.072
County	0.036*(T = 1.79)	0.321	0.048**(T = 2.20)	0.421
Ayp	-0.007(T = -0.60)	-0.066	-0.009(T = -0.73)	-0.081
WtnHis	-0.002***(T = -6.75)	-0.948	-0.002***(T = -6.84)	-0.876
Incomeper	-0.000001(T = -1.04)	-0.354	-0.000002*(T = -1.86)	-0.546
Exppupil	0.0000001(T = 0.01)	0.002	-0.000001(T = -0.32)	-0.135
Hope	-0.001**(T = -2.10)	-0.396	-0.001***(T = -2.68)	-0.479
Urt	0.007(T = 0.93)	0.315	0.008 (T = 1.02)	0.342
Awba	-0.002**(T = -2.21)	-0.397	-----	-----
Awhs	-----	-----	-0.002** (T = -2.07)	-1.531
Log-likelihood	174.30		173.98	
Overall χ^2	150.92		150.29	
N	326		326	
Censored Obs.	67		67	

Note: *, **, *** represent significance at 10%, 5%, and 1% level, respectively; T-values are in parentheses. σ = .09 (standard error = .0044) in each model specification. The marginal effects for the Tobit model are calculated as $\frac{\partial E(y|x)}{\partial x_j} = \beta_j \Phi(x\beta/\sigma)$, where Φ is standard cumulative density function.

Column 1 of Table 4 reports the estimation results using Awba as our measure of general education levels. The variables WtnHis[2], Hope, and Awba positively and significantly explain the calculated school efficiency scores. Using the marginal effects of each independent variable on the calculated school efficiency scores in column 2, several important results emerge from the analysis. We find that a 1% increase in the percentage of adults residing within the county school district with at least a bachelor's degree (Awba), the percentage of residents which recognize their race as "White" or "White, non-Hispanic" (WtnHis), and the percent of high school graduates eligible to the HOPE scholarship to correspond to a 0.39%, 0.94%, and 0.39% increase in public high school efficiency, respectively. The County variable is also significant at the 10 percent level and is negatively correlated with the efficiency scores. This suggests that city high schools are producing more output than county high schools in the state of Georgia.[3]

Column 3 of Table 4 reports regression estimates using Awhs as our measure of general education levels. The findings are almost identical to those in column 1. The variables County, WtnHis, Incomeper, Hope, and Awhs are statistically significant. The magnitudes of the majority of the coefficient estimates are almost identical to those in column 1. One difference between Columns 1 and 3 is that the coefficient on Incomeper becomes statistically significant at the 6 percent level when Awhs is used to measure education level.

As a final check on the estimates, the data are examined for outliers. With the differences in racial composition, education levels, and income levels across counties and school districts, some high schools may be outliers in particular dimensions. In addition some schools may not be quite as comparable with the rest of the schools from an aggregation perspective. Using the multivariate method for detecting outliers developed by Hadi (1994), thirty (30) high schools are identified as outliers. The large majority of these outliers are urban schools in metropolitan Atlanta with a very high share of black students or high per capita income. Others are outliers in terms of the relatively low percentage of graduates that are HOPE eligible. Re-estimating the Tobit model, we find that the coefficient signs of all the variables are unchanged, suggesting that the earlier results are not sensitive to the omission of outliers.

7. DISCUSSION

Given the same inputs, rural (non-MSA) schools should perform (equal efficiency) the same as urban (MSA) schools. Non-MSA schools have lower student-to-teacher ratios, higher average years of teaching experience, and greater percentage of teachers with advanced degrees (Table 1). Based on these factors alone, rural schools should have higher efficiency rates. These factors are overridden by a much larger percentage of disadvantaged students enrolled in rural schools. Students from lower socioeconomic backgrounds tend to have a greater likelihood of having a learning disability. Students with learning disabilities have a lower graduation rate than those that do not. To make significant progress, the State of Georgia needs to address this graduation differential.

With the recent (2009) passage of two new laws that have been signed by Governor Perdue of Georgia, the opportunity for additional funding is limited. The first is a law that freezes property tax assessments in Georgia for the next three years. In a locality where property tax assessments have been frozen, the tax digest remains constant. With an unchanging tax digest, only changes in the millage rate can increase the property tax revenues received by local school districts (assuming no net in-migration of households or businesses that would alter the tax digest). The second is a law that requires tax assessors to consider distressed and foreclosed properties in their tax assessment calculations. These laws, coupled with our results, suggest that schools need to give serious consideration to reallocating resources or changing the expenditure mix to improve efficiency.

Some high schools have adopted a co-teaching model. In the recent past, schools placed children with learning disabilities in separate classrooms with special education teachers. The special education teachers were generalists and typically not well-versed in all content areas. The co-teaching model places the children with learning disabilities in the same class as children without disabilities. The special education teacher becomes the co-teacher. The children with learning disabilities receive their content from a qualified content teacher and receive additional assistance as needed from the in-class special education teacher. Local anecdotal accounts suggest an increase in achievement levels using this model.

Also, Georgia's lottery-funded HOPE Scholarship Program is arguably the most successful educational initiative for the higher level of academic achievement. While it provides an incentive (tuition assistance depending on the type of institution in which one is enrolled) for students to perform well in high school courses in preparation for university level study, we cannot directly measure the impact of the HOPE scholarship in this study.

8. CONCLUSION

This paper provides empirical support of the difference in educational efficiency between urban and rural public high schools in State of Georgia. Using a two-step estimation process to evaluate efficiency, the mean efficiency scores are found to be significantly different between urban and rural high schools. Specifically, rural schools operate less efficiently than urban schools. This outcome is important to regional scientists who continue to analyze rural education issues (Beaulieu and Gibbs, 2005).

A double truncated regression analysis is employed to estimate the impact of educational policy, community environment, and school characteristics on efficiency scores. Some of these factors are neither inputs nor outputs in the education production process, but rather circumstances faced by a particular school. It is clear from the second stage Tobit analysis that the estimated percentage of adults residing in the county school district with at least a bachelor's degree, the estimated percentage of adults residing in the county school district with at least a high school degree, the number of people residing in the county who recognize their race as "White, non-Hispanic", and the percentage of students that are eligible for HOPE scholarship are associated with high levels of school educational efficiency.

These results were expected. The educational attainment of parents can play a significant factor in influencing academic achievement. DMUs with more human capital have higher levels of school efficiency as a result of parents who are more able to help their children learn and have greater involvement in their child's education.

Another finding of this study is that the state and local government expenditures per pupil do not significantly explain the educational efficiency of high schools. This result may be due to using aggregated level of per pupil expenditures by each *school district* instead of using data on the state and local government expenditures per pupil in each *high school*. Using the same line of thought, Adequate Yearly Progress (AYP), a federal requirement under No Child Left Behind (NCLB), is not a contributing factor of high school educational efficiency. So, the federal government might consider the reallocation of existing expenditures in ways that improve school performances.

In conclusion, this study focused on assessing the technical efficiency of public high schools for a given year. Future research could analyze the efficiency differences over time and across subgroups in the panel data setting. Because of unavailability of data, the effects of state and local fiscal policies on the efficiency scores are not precisely identified. So, further research and better data are needed to fully explore the educational efficiency differences between urban and rural public high schools.

ENDNOTES

1. State education data are publicly available at www.schooldatadirect.org, which is an online service of the State Education Data Center.
2. The correlation between percentage of people residing in the county who recognize their race as "white" but not "Spanish/Hispanic/Latino" and percentage of residents who recognize their race as "Black" is 0.94. Because of high correlation between Wtnhis and Black, the second stage TOBIT regression is estimated by including the Wtnhis alone. However, identical results are obtained by including Black variable into the Tobit regression.
3. In preliminary runs of the Tobit model, inclusion of the interaction term County*Msa did not suggest that county schools that were also in MSA counties had significantly different efficiency scores.

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