

# A Multivariate Analysis of Educational Productivity in Urban Georgia High Schools

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**Abstract:** Most education production studies use univariate methods, thereby compromising the very essence of the multivariate nature of education production. This study employed multivariate methods to examine and explain the relationships between three educational inputs and two outputs using a data matrix from 71 high schools in six schools districts in the metropolitan Atlanta, Georgia area. The findings indicated statistically significant differences between districts on the composites of inputs and outputs. When the variables were grouped as multivariate functions, the economic background of students, the fiscal context of the schools, and the achievement measures occurred in this order of importance respectively. Canonical analysis indicated significant multivariate relationships between the composites of inputs and outputs. Linear multivariate production models were constructed to express the nature of the relationships between the multiple inputs and outputs.

## Introduction

The National Center for Education Statistics (U. S. Department of Education, 2003a, Table 166) reported that average current expenditure per pupil in public schools was \$7,376 in 2001-2002. Over the past decade total expenditures per pupil have increased by 20% on the average (U. S. Department of Education, 2003b). The perception that student performance is not commensurate with growing expenditure on K-12 public education has been the subject of debate for decades (Clotfelter & Ladd, 1999; Coleman, 1968; Coleman, Easton, & LaRocque, 1998; Coleman, et al. 1966; Hanushek, 1981, 1989; Klick, 2000). The general consensus of the many studies that examined the relationship between educational resource inputs and student achievement is that resource inputs do matter in determining student achievement depending on the way resources are allocated and utilized (Greenwald, Hedges, & Laine, 1996; Hanushek, 1981, 1989, 1996; Klick, 2000; Monk, 1992). Most of these studies used production function to measure education productivity.

Education productivity measurement involves selecting a set of existing educational input variables and a corresponding set of output measures and establishing the relationship between the inputs and the outputs (Monk, 1992). The measurement often involves the use of linear regression, correlation, or multivariate-discriminant analysis to indicate the nature of the relationship (Goldhaber & Brewer, 1997a; Monk, 1992; Montmarquette & Majseredjian, 1989;

Mortimore, Simmons, Stoll, Lewis, & Ecob, 1988; Murnane, 1975; Smith & Tomlinson 1989; Walberg, 1982; Walberg & Fowler, 1989; Walberg & Weinstein, 1982; Wenglinsky, 1997). Approximately 400 studies have been reported including those that have been evaluated and summarized using meta-analysis (Greenwald, et al., 1996; Hanushek, 1997; Hedges, Laine & Greenwald, 1994).

Most of these education productivity studies examined the relationship between two or more educational input variables and one educational output measure (usually student achievement) using univariate analysis (Hanushek, 1997). The general univariate model is:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \dots + b_kX_k$$

where  $Y$  is a single educational output measure;  $a$  is the intercept of the regression line on the output measure;  $b_1, b_2, b_3, \dots, b_k$  are the regression coefficients associated with  $X_1, X_2, X_3, \dots, X_k$ , the educational input variables.

In education, there is often more than one output measure for a given set of inputs. Education productivity studies must examine the relationship between sets of input variables and sets of output measures as multivariate composites (Pedhazur, 1997). Heinbuch and Samuels (1995) and Tatsuoka (1988) have noted that very little concerted effort has been made to establish the nature of the relationship between multiple educational inputs and multiple measures of student achievement using multivariate methods. Pedhazur also noted that simply calculating zero-order correlations for all possible pairs of variables using univariate tests on data with multivariate constructs "... affects the prescribed  $\alpha$  level" ( p. 895) thus increasing the chance for a Type 1 error. Moreover, analyzing multivariate context data using a series of univariate methods compromises the very essence and richness of a multifaceted phenomenon, such as education production.

In a multivariate context, education production examines the relationship between a set of two or more educational input variables and a set of two or more educational output variables (Pedhazur 1997; Tatsuoka, 1973; Tatsuoka, 1988). The general multivariate model may be expressed as:

$$a_1Y_1 + a_2Y_2 + a_3Y_3 \dots + a_kY_k = b_0 + b_1 X_1 + b_2X_2 + b_3X_3 + \dots + b_mX_m$$

where,  $a_1, a_2, a_3, \dots, a_k$  are the coefficients associated with  $Y_1, Y_2, Y_3, \dots, Y_k$ , the linear composite of educational output measures;  $b_0$  is the intercept of the composite regression line on the linear composite of output measures; and  $b_1, b_2, b_3, \dots, b_m$  are the regression coefficients associated with  $X_1, X_2, X_3, \dots, X_m$ , the linear composite of educational input variables,

This study used multivariate methods to examine the relationships between a set of three educational input variables and two educational output measures. Based on the multivariate model explained above, the overall production function model for this study is:

$$a_1Y_1 + a_2Y_2 = b_0 + b_1 X_1 + b_2X_2 + b_3X_3$$

where,  $X_1, X_2, X_3$  are three educational input variables;  $Y_1, Y_2$ , are two output measures;  $a_1, a_2$ , are the coefficients or weights of the linear composite of outputs in the regression model; and  $b_1, b_2, b_3$  are the coefficients or weights of the linear composite of the inputs in the regression model.

## Data

This study relied on electronic archival data (State Report Cards and State Allotment Sheets for 2000-2001 and 2001-2002 school years)<sup>1</sup> from the Georgia Department of Education. The sample for this study was six of the largest metropolitan Atlanta school districts which combined had 71 high schools and enrolled about 26% of the total public high school enrollment in Georgia.

Data were collected for the three input and two output measures. The first input variable was **expenditure per pupil (EXPPP)** at the high school building level. This study used the Quality Basic Education (QBE) final allotment or earnings data that includes both state and local contributions to the foundation funding in Georgia. The allotments are calculated for the building level thereby having a measure of dollars dedicated to direct classroom instruction and instructional support.<sup>2</sup> Although Georgia uses a weighting system, the regular high school student is the base funding easing the way to calculating a per pupil expenditure at each high school. Because districts are required to spend all of these dollars as they are allotted, the allotment is a reasonable proxy for expenditures per pupil.

The second input variable was **teacher quality (TEACHQLT)**. Most of the literature on teacher quality (Figlio, 1999; Goldhaber & Brewer 1997b; Goldhaber, Brewer, & Anderson, 1999; Mancebon & Bandres, 1999) only takes into consideration either the years of service (experience) or the highest education degree attainment (qualification) of the teachers considered separately. Other research has considered other factors such as verbal expression ability and scores on standardized certification tests (Firestone, 1991). Using only one of these measures as a proxy for teacher quality produces a downward or an upward bias depending on the relativity of qualification to experience for each teacher considered. A composite of these measures reflects a more representative proxy for teacher quality than just looking at one of the measures in isolation. This study builds on these previous works by using a combination of experience and qualification, used by the Georgia Department of Education to determine teacher quality.

**TEACHQLT** was determined by transforming the state data on teacher experience and degree attainment for each of the sample schools. The transformation calculation to obtain the values for TEACHQLT used the formula:

$$\text{TEACHQLT} = (((N_{q1}Q_1 + N_{q2}Q_2 + N_{q3}Q_3 + N_{q4}Q_4 + N_{q5}Q_5) + (N_{e1}E_1 + N_{e2}E_2 + N_{e3}E_3 + N_{e4}E_4 + N_{e5}E_5))/N_{ts})) \times 100$$

where:  $Q_1$  to  $Q_5$  is Non-certified, Bachelor's, Master's, Specialist, and Doctoral qualifications respectively;  $N_{q1}$  to  $N_{q5}$  is the number of teachers with the corresponding  $Q$  (qualifications) respectively;  $E_1$  to  $E_5$  is the years of experience in each corresponding  $Q$  categories respectively. The range of  $E$  values is  $E_1 = 1$  (less than 1 year experience),  $E_2 = 2$  (1-10 years experience);  $E_3 = 3$  (11-20 years experience);  $E_4 = 4$  (21-30 years experience), to  $E_5 = 5$  (greater than 30 years experience). And where  $N_{e1}$  to  $N_{e5}$  = Number of teachers with the corresponding  $E$  (experiences) respectively; and  $N_{ts}$  = Total number of students enrolled in the school for the corresponding school year. Table 1 is an example of the transformation calculation for a typical sample high school.

Table 1

Transformation Calculation for Teacher Quality

<u>Qualification</u>	<u>Number of Teachers (N<sub>q</sub>) x</u>	<u>Qualification Wt. (Q) =</u>	<u>Value</u>
Bachelor	12 (N <sub>q1</sub> )	2 (Q <sub>1</sub> )	24
Master	20 (N <sub>q2</sub> )	3 (Q <sub>2</sub> )	60
Specialist	2 (N <sub>q3</sub> )	4 (Q <sub>3</sub> )	8
Doctorate	1 (N <sub>q4</sub> )	2 (Q <sub>4</sub> )	3
Other	2 (N <sub>q5</sub> )	1 (Q <sub>5</sub> )	2
<hr/>			
<u>Experience (E)</u>	<u>Number of Teachers (N<sub>e</sub>) x</u>	<u>Experience Wt. (E) =</u>	<u>Value</u>
< 1 year (E <sub>1</sub> )	1 (N <sub>e1</sub> )	1 (E <sub>1</sub> )	1
1-10 years (E <sub>2</sub> )	6 (N <sub>e2</sub> )	2 (E <sub>2</sub> )	12
11-20 years (E <sub>3</sub> )	12 (N <sub>e3</sub> )	3 (E <sub>3</sub> )	36
21-30 years (E <sub>4</sub> )	12 (N <sub>e4</sub> )	4 (E <sub>4</sub> )	48
>30 years (E <sub>5</sub> )	7 (N <sub>e5</sub> )	5 (E <sub>5</sub> )	35
<b>Total Value</b>			<b>229</b>

Note: If total number of enrolled students for the school year = 627, the TEACHQLT index =  $229/627 \times 100 = 36.50$ . Transformation based on the Training & Experience (T & E) Scale for Teachers, Georgia Department of Education.

Education productivity study is not complete without a measure of the **percentage of economically disadvantaged students (PEDS)** as a factor (Alexander, 1997). Of the 1.4 million students who attend Georgia’s public schools, approximately 44% are eligible for federal free and reduced lunch prices (FRL). Eligibility for the federal program was used as the measure of **PEDS**. Many research studies used the socioeconomic status of students (SES)<sup>3</sup> as the controlling variable (Figlio 1999; Hanushek, 1986, 1989, 1991; Mancebon & Bandres, 1999; Monk, 1992; Walberg, 1982). In this study, **PEDS** is used both as an input variable and as a controlling factor.

The first output measure is percentage of **students passing the science section of the Georgia High School Graduation Test (GHSGT)**. To receive a high school diploma, a student is required to pass three science courses (biology, physical science, and either chemistry or environmental science) and pass the GHSGT including the science section (OCGA 20-2-281). Thus, performance on the GHSGT is an important measure of educational output. Percentages of students passing the science section on first sitting were retrieved from the State archival database.

The second output measure is eligibility for the HOPE scholarship (**HOPE**). The Georgia HOPE scholarship program was established in 1993 to provide lottery-derived money for tuition and books for students, who are residents of Georgia, pursuing post-secondary education programs in colleges and universities in the state (Georgia HOPE scholarship program, 1997).

To qualify for HOPE during a student’s first year in college, the student must have an exit Grade Point Average (GPA) of not less than 3.0 on a 1.0 - 4.0 scale, at graduation from an accredited high school in the state. Everyone who meets the GPA criterion gets the scholarship. The eligibility for the HOPE scholarship provides a measure of student achievement that is not

based on a test score. Rather the GPA is calculated using the teacher assigned grades for courses students took in grades 9 – 12. Therefore, the percentage of students qualifying for the HOPE scholarship is also an important measure of educational output. Data on graduating students qualified for the HOPE scholarship for each high school were retrieved from the State archival records.

Seven hypotheses guided the study. These hypotheses, the methods used to test them, and the results are presented in the next sections.

### Data Analysis Approach

Combinations for Multivariate Analysis of Variance (MANOVA), Canonical Correlation Analysis (CCA), and Multivariate Regression Analysis (MRA) were used in the analysis of the data.

MANOVA, provides: (1) the significance of the overall group separation or difference on the bases of the multivariate composites, by examining the Wilks'  $\Lambda$  value and its F-statistic; (2) the significance of each input and output variable at defining the group differences by looking at their individual F-statistics and the corresponding effect sizes; (3) the magnitude of the contribution of each of the input and output variables to the group differences by looking at the standardized weights and the structure coefficients of each variable. A univariate ANOVA is not appropriate to analyze the linear composites of both input and output variables, simultaneously in this manner (Tatsuoka, 1988).

The conceptual reasoning behind CCA is to form two linear combinations of the input variables and the output variables by differentially weighting them to obtain the maximum possible correlation between the two linear combinations (Pedhazur, 1997). In this study, the number of possible  $C_r$ 's (canonical functions) is 2; the number of educational achievement output measures. The number of  $C_r$ 's selected finally for meaningful interpretation depends on their statistical and practical significances.

For the Multivariate Regression Analysis (MRA), the linear composite multivariate regression model for this study may be written as:

$$a_1GHS GT + a_2HOPE = b_0 + b_1 EXPPP + b_2TEACHQLT + b_3PEDS$$

where;  $EXPPP$ ,  $TEACHQLT$ , &  $PEDS$  is the linear combination of input variables;  $GHS GT$  &  $HOPE$  = linear combination of achievement output measures;  $b_0$  = intercept of the composite regression line on the composite of performance measures;  $b_1$ ,  $b_2$ ,  $b_3$ , are the regression coefficients associated with the input variables;  $a_1$ ,  $a_2$  are the regression coefficients associated with the output variables. Multivariate regression analysis produced statistical values for both multivariate as well as univariate measures. The individual regression model for each performance measure on the composite of the input variables was inferred from the univariate analysis output produced as part of the multivariate analysis. The univariate linear regression models were constructed. The univariate linear regression models tested by the MRA analysis can be written as:

$$\begin{aligned} GHS GT &= a + b_1 EXPPP + b_2TEACHQLT + b_3PEDS \\ HOPE &= a + b_1 EXPPP + b_2TEACHQLT + b_3PEDS \end{aligned}$$

Each of the above multiple linear (univariate) regression models, was checked and tested for  $R^2$  change.

Using multivariate analysis approach for this study assumes the following: (1) The input and output variables were multivariately normally distributed across the sampling population, and each variable measure in each school is also normally distributed across all the population. Because the sample size is large, violation of this assumption would have little or no effect on the statistical validity of the results of this study. (2) The variation among the performance measures was the same across all the levels of the factors. The variances of the performance measures are positively proportional to the sample size. The SPSS Base 10.0 computer program used in the analysis of the data allowed the researchers to test, explain, and make adjustment for these assumptions. (3) The scores on the selected variables for each sampling unit were independent of each other. As each school was a distinct unit from each other on the selected variables, this assumption was met in this study. (4) The multiple regressions of the input factors against specific student performance measures were linear. This was the basis for production function and multivariate regression-correlation analysis. The selection of variables was based on the high possibility of obtaining extreme values for each variable to optimize group separation on the performance measures (Cox, 1958; Dolan & Schmidt, 1987).

### Hypotheses, Methods, and Findings

As stated earlier, the scores on the variables used in this study cover two consecutive years. There is no relationship between one year's score and the other because each year's score is independent of the next year. First the descriptive statistics are presented followed by the inferential statistics. To provide a more stringent and robust interpretation of the data, the multivariate analysis methods used the pooled statistics of the variables for the two consecutive years of available data.

#### *Descriptive Statistics*

Table 2 displays the means and standard deviations for each of the variables across the six districts. Two sets of observation elements, corresponding to the two years of data, were collected on each of the 71 high schools. There was little variation across the six districts for four of the five variables: (EXPPP), (TEACHQLT), (GHSGT), and HOPE. There was a high degree of variance between the districts on the PEDS measure. District BB had only 10.87% of students eligible for free and reduced lunch while District TL had 66.31% eligible. The finding that the district with the lowest percent of economically disadvantaged students had the highest means for students passing the GHSGT and for eligibility for HOPE is not surprising. Teacher quality is perhaps the most surprising finding in that the district with the most PEDS (TL) also had the highest TEACHQLT, dispelling the idea that teachers with more experience and more education are more likely to be found in more affluent school districts.

Table 2

Descriptive Statistics for Input and Output Variables

School District	EXPP Mean (SD)	TEACHQLTY Mean (SD)	PEDS Mean (SD)	GHSGT Mean (SD)	HOPE Mean (SD)	Observations	Schools
TL	2,702.82 (233.17)	34.47 (5.73)	66.31 (14.88)	57.27 (16.03)	49.71 (13.81)	22	11
YT	2,924.79 (323.61)	27.49 (3.09)	39.56 (10.47)	63.64 (7.98)	54.81 (7.33)	14	7
BB	2,786.73 (223.82)	32.16 (3.39)	10.87 (10.39)	79.81 (11.86)	68.54 (9.56)	26	13
KL	2,799.26 (227.41)	29.57 (4.47)	40.06 (17.43)	65.53 (14.49)	61.33 (10.38)	34	17
LT	2,402.05 (154.10)	33.23 (3.27)	22.83 (19.50)	73.85 (15.00)	66.95 (16.32)	20	10
WN	2,988.62 (233.74)	31.58 (3.54)	14.32 (11.74)	76.80 (8.31)	62.20 (9.67)	26	13
Average	2,773.13 (288.05)	31.48 (4.53)	31.56 (13.77)	69.92 (14.94)	61.16 (12.91)	142	71

Note: Total number of schools sampled is 71; two observations representing 2 years of data were used.

*Inferential Statistics*

Hypothesis 1: There are no significant differences between school districts on the composite of educational input variables and the composite of achievement output measures.

MANOVA was used to test for significant differences between the districts on the linear composite of the input and output variables and to determine the extent to which each of these variables, as a linear composite, contributes to the separation of the districts. The follow-up dimensionality test revealed the magnitude and extent of the contributions to the differences between the districts. Table 3 shows the results.

Table 3

Multivariate Test of District Differences on the Composite of Inputs and Outputs

<u>Statistic</u>	<u>Value</u>	<u>Hypothesis df</u>	<u>Error df</u>	<u>F</u>	<u>p</u>	<u><math>\eta^2</math></u>
Wilks $\Lambda^*$	.0869	25	652	18.295	0.000	.435

<u>Function</u>	<u>Eigenvalue(<math>\lambda</math>)</u>	<u>Cumulative %</u>	<u>Canonical Correlation</u>	<u>p</u>
1	3.528	73.62	.883	.000
2	1.009	94.67	.709	.000
3	0.215	99.16	.421	.000

<u>Variables</u>	<u>Standardized</u>	<u>Coefficients</u>	<u>3</u>
EXPPP	.605	.841	.231
TEACHQLT	.632	.800	.613
GHSQT	.648	.179	.994
HOPE	.143	.152	.891
PEDS	1.798	.407	.134

\*Significant at  $\alpha = .05, p < .001$

The analysis indicates that the six districts do not have identical mean vectors on the input and output variables,  $\Lambda = .0869$  at  $F_{(25,652)} = 18.295, p < .001$ . District membership explained 43.5% of the variance in the composite scores ( $\eta^2 = .435$ ).

The test of dimensionality and structure analysis of the districts' differences, on the linear composite of the variables showed that five discriminant functions, with respective Eigenvalues ( $\lambda$ ) = 3.528, 1.009, 0.215, 0.039, and 0.001, were produced out of the six-district groupings. Three out of the five possible functions carried enough cumulative percentage (99.164%) with their respective Eigenvalues ( $\lambda=3.528, \lambda=1.009, \lambda=0.215$ ) significant enough to define the separation of the districts on the composite of the input and output variables.

The standardized discriminant function coefficients indicated that the first of the three significant functions was a student economic construct defined by PEDS (standardized coefficient = 1.798). The second construct was fiscal defined by both EXPPP (standardized coefficient = .841), and TEACHQL (standardized coefficient = .800). The third construct was achievement defined by both GHSQT and HOPE with standardized function coefficients of .944 and .891 respectively.

Given the relatively low Eigenvalue ( $\lambda=0.215$ ) and the very low marginal cumulative percentage contribution (4.49%) of the third function to the dimensionality of the discriminant functions, the results indicate that the differences between the districts were mostly defined by the first two functional constructs; economic status of students (PEDS) and fiscal (EXPPP and TEACHQLT). The basis of both constructs is money.

Hypothesis 2: There are no significant differences between school districts on each of the input variables and the output measures considered separately.

Levene's test of homogeneity-of-variance was performed as a required background test for the assumption of homogeneity. The test indicated non-significance for EXPPP  $F_{(5,136)} =$

0.907,  $p = .479$ ; and TEACHQLT  $F_{(5,136)} = 1.863$ ,  $p = .105$ ; but significance for PEDS  $F_{(5,136)} = 6.103$ ,  $p < .001$ ; GHSGT  $F_{(5,136)} = 5.611$ ,  $p < .001$ ; and HOPE  $F_{(5,136)} = 7.124$ ,  $p < .001$ . Given the large sample size (71 schools), the values for the Levene's Test indicate no serious violation of homogeneity. The variances were reasonably equal across the groups. Moreover, a closer inspection of the grouping variances and their respective sample sizes indicated positive relationships across the variables--EXPPP ( $r = .783$ ), TEACHQLT ( $r = .256$ ), PEDS ( $r = .304$ ) GHSGT ( $r = .284$ ), and HOPE ( $r = .054$ ). Because the relationship between variances and sample sizes is positive the tests are conservative.

The univariate test results (see Table 4) indicated that there were significant differences between the six districts on all input and output variables. The composite of input and output variables was significantly different among the six schools districts. PEDS explained the highest proportion of variation (63%,  $\eta^2 = .630$ ) between the districts, followed by EXPPP and GHSGT with each explaining 37.8% ( $\eta^2 = .378$ ) of the variation.

Table 4

Univariate Test of District Differences on Inputs and Outputs Individually

Variables	Hypothesis <i>MS</i>	Error <i>MS</i>	<i>F</i>	<i>p</i>	$\eta^2$
EXPPP*	884015.450	53523.6652	16.51635	0.000	0.378
TEACHQLT*	123.31089	16.73420	7.36879	0.000	0.214
PEDS*	100043.1886	216.68517	46.43922	0.000	0.630
GHSGT*	1762.06210	166.68144	10.57144	0.000	0.378
HOPE*	1113.08073	131.88859	8.43955	0.000	0.237

\*Significant at  $\alpha = .05$ ,  $p < .001$

Figure 1 graphically summarizes the multiple (Bonferroni) comparisons between districts on the input and output variables. WN school district was higher than all the other school districts except for district YT on EXPPP variable. School district LT had the lowest EXPPP and was significantly different from the remaining five school districts. There were no significant differences between TL, BB, KL, and YT on EXPPP.

TEACHQLT was higher in district TL than in districts KL and YT. There were no significant differences between districts WN, BB, LT, and TL on TEACHQLT. District YT had the lowest TEACHQLT compared with the other school districts, except for district KL where there was no significant difference.

On PEDS, district TL was significantly higher than the other school districts. There was no significant difference between districts KL and YT. Similarly, there was no significant difference between districts BB and WN.

On GHSGT, district TL was significantly lower than the remaining school districts, except for districts YT and KL. There were no significant differences between districts LT, WN, and BB. Districts WN and BB had a significantly higher GHSGT than districts TL, YT, and KL.

On HOPE, District TL was significantly lower than the remaining districts, except for district YT. There were no statistically significant differences between districts KL, WN, TL, and BB. District YT was not significantly higher than districts KL and WN. District BB showed a significantly higher difference when compared with TL and YT, but was not different compared with KL, WN, and LT.

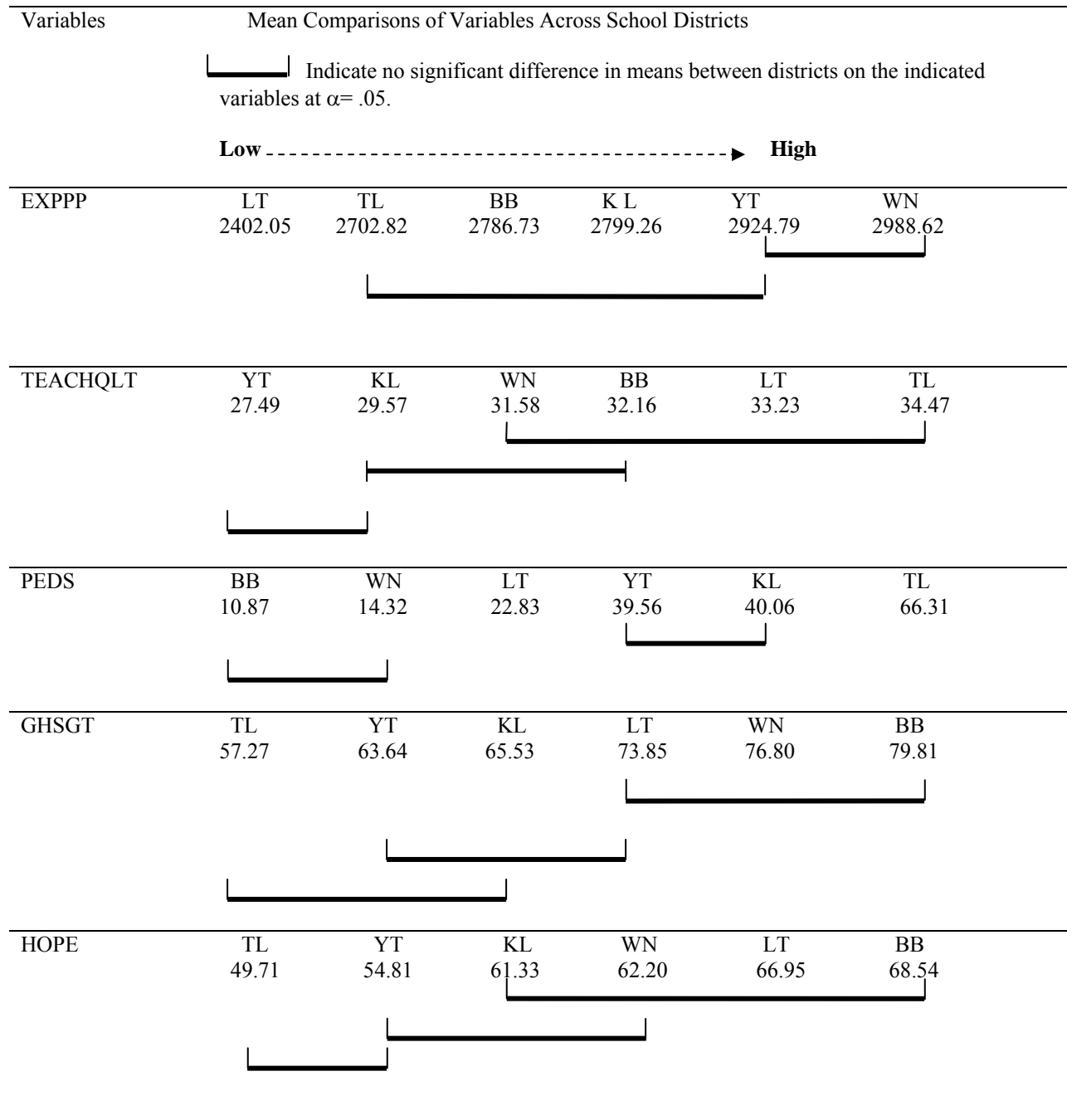


Figure 1. Multiple Mean Comparisons of Inputs and Outputs Across School Districts

*Hypothesis 3:* There is no significant difference between school districts on the composite of educational inputs and outputs after controlling for PEDS.

This hypothesis was tested using Multivariate Analysis of Covariance (MANCOVA) with PEDS as the covariate to compare the districts on the remaining input-output variables after controlling for PEDS.

A test of homogeneity of the vectors of regression slopes among the six districts indicated that the slopes were equal and therefore the assumption of equal regression slopes appears to be met. Appropriate adjustments were made to the means of the remaining variables using PEDS as covariate (see Table 5).

Table 5

Observed and Adjusted Means of Inputs and Outputs after Controlling for PEDS

District	EXPPP		TEACHQLT		GHSQT		HOPE	
	Obs. Mean	Adj. Mean <sup>a</sup>	Obs. Mean	Adj. Mean <sup>a</sup>	Obs. Mean	Adj. Mean <sup>a</sup>	Obs. Mean	Adj. Mean <sup>a</sup>
TL	2702.82	2521.88	34.47	32.12	57.27	81.63	49.71	69.70
YT	2924.79	2887.65	27.49	27.01	63.64	68.64	54.81	58.91
BB	2786.73	2900.47	32.16	33.63	79.81	64.49	68.54	55.97
KL	2799.27	2757.99	29.57	29.03	65.53	71.08	61.33	65.89
LT	2402.05	2452.23	33.32	33.88	73.85	67.10	66.95	61.40
WN	2773.13	3084.03	31.48	32.82	76.81	63.96	62.20	51.65

<sup>a</sup> Adjusted Means based on the pooled relationship between PEDS and the other variables. Wilks  $\Lambda = .25303$ ,  $F_{(4,132)} = 97.42045$ ,  $\alpha = .05$ ,  $p < .001$

After adjusting for PEDS, school district WN now has the highest EXPPP while district LT remains as the lowest. School district LT now has the highest TEACHQLT while district YT remains as the lowest. After controlling for PEDS, school district TL has moved from having the lowest mean to the highest adjusted mean for GHSQT; district WN now has the lowest mean. Correspondingly, school district TL now has moved from the lowest HOPE score to the highest, while district WN now has the lowest.

After controlling for PEDS, the multivariate test of significance between the districts on the composite of the remaining variables indicated that the districts were still significantly different with Wilks  $\Lambda = 0.23512$  at  $F_{(20,439)} = 12.005$ ,  $p < .001$ ,  $\eta^2 = .747$ . The composite of remaining variables explained 74.7% of the variation (see Table 6).

A statistical test for dimensionality showed that four possible functions (Eigenvalues ( $\lambda$ ) 1.597, 0.388, 0.144, and 0.031) describe the dimensionality of the district differences after controlling for PEDS (See Table 6). Three of the four functions carried enough cumulative percentage (99.55%) with Eigenvalues ( $\lambda$ ) = 1.597,  $\lambda = 0.388$ , and  $\lambda = 0.144$  respectively to significantly define the dimensionality and structure of the separation of the districts on the composite.

Table 6

Multivariate Test of District Differences on the Composites of Inputs and Outputs after Controlling for PEDS

<u>Statistic</u>	<u>Value</u>	<u>Hypothesis df</u>	<u>Error df</u>	<u>F</u>	<u>p</u>	<u><math>\eta^2</math></u>
Wilks $\Lambda^*$	.23512	20	439	12.005	0.000	.747

<u>Function</u>	<u>Eigenvalue(<math>\lambda</math>)</u>	<u>Cumulative %</u>	<u>Canonical Correlation</u>	<u>p</u>
1	1.528	73.93	.784	0.00
2	0.388	91.90	.529	0.00
3	0.144	98.55	.354	0.00
4	0.031	100.00	.174	0.00

<u>Variables</u>	<u>Standardized Coefficients</u>		
	1	2	3
EXPP	.989	.107	.279
TEACHQLT	.551	.813	.218
GHSQT	.225	.185	.928
HOPE	.437	.533	.227

\*Significant at  $\alpha = .05, p < .001$

The standardized coefficients and their corresponding canonical loadings, after controlling for PEDS, indicated that the first of the three significant functions was defined by EXPPP with a standardized coefficient = .989, explaining 47.61% (structure  $r = .690$ ) of the functional characteristics. The second function was defined by TEACHQLT with a standardized coefficient = .813, explaining 58.82% of the characteristics of the function (structure  $r = .767$ ) and HOPE with a standardized coefficient = .533 explaining, explaining 36.00% of the characteristics of the function (structure  $r = .600$ ). The third function was defined by GHSQT with a standardized coefficient = .928 explaining 80.10% of the characteristics of the function (structure  $r = .895$ ). Therefore, after controlling for PEDS, district differences were determined by EXPPP and TEACHQLT as a fiscal construct followed by GHSQT and HOPE as an achievement construct.

*Hypothesis 4:* There is no significant difference between school districts on each of the educational input and output variables considered separately, after controlling for PEDS.

The univariate  $F$ -test for differences between the districts on the vector of each of the variables considered separately (and controlling for PEDS) indicated a highly significant difference on each of the variables. See Table 7.

Table 7

Univariate Test of District Differences on Inputs and Outputs Individually After Controlling for PEDS.

Variables	Hypothesis <i>MS</i>	Error <i>MS</i>	<i>F</i>	<i>p</i>	$\eta^2$
EXPPP	1031269.49	47752.11	21.596 *	0.000	.444
TEACHQLT	134.16	15.81	8.482 *	0.000	.239
GHSQT	396.61	56.71	7.061 *	0.000	.207
HOPE	553.14	57.55	9.611*	0.000	.263

\*Significant at  $\alpha = .05, p < .05$

Hypothesis 5: There is no significant correlation between the composite of educational input and output variables across school districts.

Table 8 shows that the overall multivariate canonical correlation was defined by only one of the two possible functions, with an overall correlation ( $Cr = .851$ ), explaining 75.4% of the correlation. The highly significant result that the remaining canonical correlations were zero, with Wilks  $\Lambda = 0.274$  at Chi-squared,  $\chi^2_{(6)} = 178.886, p < .001$  confirmed the high extent of the composite correlation. The standardized coefficients and canonical loadings (shown in Table 8) indicated that PEDS defined the single function. PEDS explained the largest proportion of the overall correlation between the composite of input variables (EXPPP, TEACHQLT, PEDS) and the composite of output measures (GHSQT, HOPE).

Table 8

Canonical Correlations and Dimensionality of the Relationship Between the Composites of Inputs and Outputs.

Canonical Function	Wilks	$\chi^2$	<i>df</i>	<i>p</i>	<i>Cr</i>	$\eta^2$
1	0.274*	178.886	6	.000	.851	.754
2	0.989	1.472	2	.479	.103	.011

Input Variables	Standardized Coefficient	Canonical Loadings
EXPPP	.071	.159
TEACHQLT	.012	.170
PEDS	.993	.998

\*Significant at  $\alpha = .05, p < .01$

Hypothesis 6: There are no significant correlations between the individual input and output variables, considered univariately, across school districts.

Table 9 shows that significant positive correlations exist between EXPPP and TEACHQLT and between GHSQT and HOPE. Four significant negative correlations exist: between GHSQT and PEDS; between HOPE and PEDS; between TEACHQLT and HOPE; and between EXPPP and HOPE. Other negative relationships between variables were weak and not statistically significant.

Table 9

Correlation Coefficients of the Univariate Relationships Between Individual Inputs and Outputs

<u>Variables</u>	<u>EXPPP</u>	<u>TEACHQLT</u>	<u>PEDS</u>	<u>GHSQT</u>	<u>HOPE</u>
EXPPP	-----	.1450*	.0908	-.1151	-.1644*
TEACHQLT		-----	.1727*	-.1329	-.1499*
PEDS			-----	-.8343*	-.7428*
GHSQT				-----	.7727*
HOPE					-----

\*Significant at  $p < .05$

*Hypothesis 7:* There is no significant linear relationship between the linear composite of input variables and the linear composite of output measures.

The multivariate regression analysis using General Linear Model (GLM) indicated that the overall composite of input variables (EXPPP, TEACHQLT, and PEDS) had a highly significant linear relationship with the overall composite of output measures (GHSQT and HOPE) with Wilks  $\Lambda = .274$  at  $F_{(6,274)} = 41.647$ ,  $p < 0.001$  explaining 47.7% ( $\eta^2 = 0.477$ ) of the multivariate linear relationship (see Table 10).

However the multivariate test of the individual input variables (EXPPP, TEACHQLT, and PEDS) on the linear composite of output measures (GHSQT and HOPE) indicated that only PEDS made a highly significant contribution to the linear composite relationship, with Wilks  $\Lambda = .286$  at  $F_{(2,137)} = 170.783$ ,  $p < .001$ , explaining 71.40% ( $\eta^2 = 0.714$ ) of the multivariate linear composite relationship.

Table 10

Multivariate Test of Linear Regression (Relationship) Between the Linear Composites of Inputs and Outputs

<u>Input Variables</u>	<u>Wilks <math>\Lambda</math></u>	<u>Hypothesis <math>df</math></u>	<u>Error <math>df</math></u>	<u>F</u>	<u>p</u>	<u><math>\eta^2</math></u>
All Predictors	0.274*	6	274	41.647	.000	.477
EXPPP	0.979	2	137	1.440	.241	.021
TEACHQLT	0.998	2	137	0.121	.886	.002
PEDS	0.286*	2	137	170.783	.000	.714

\*Significant at  $\alpha = .05$ ,  $p < .001$

Table 11

Univariate Regression Coefficients of the Linear Relationships Between Inputs and Outputs

<u>GHSGT</u>								
<u>R<sup>2</sup></u>		<u>Adjusted R<sup>2</sup></u>						
.698		.691						
<u>HOPE</u>								
<u>R<sup>2</sup></u>		<u>Adjusted R<sup>2</sup></u>						
.561		.552						
<u>Input Variables</u>	<u>Parameter (β<sub>0</sub>, β)</u>	<u>Co-efficient</u>	<u>SE</u>	<u>t</u>	<u>p</u>	<u>95% CI</u>		<u>η<sup>2</sup></u>
						<u>Lower</u>	<u>Upper</u>	
GHSGT	Intercept	90.689	7.828	11.586	.000	75.21	106.17	.493
	EXPPP	-0.002	0.002	-0.885	.378	-0.007	0.003	.006
	TEACHQLT	-0.057	0.158	0.359	.720	-0.256	0.369	.001
	PEDS*	-0.524	0.030	-17.508	.000	-0.583	-0.465	.690
HOPE	Intercept	86.545	8.152	10.617	.000	70.43	102.663	.450
	EXPPP	-0.004	0.003	-1.690	.093	-0.009	0.001	.020
	TEACHQLT	-0.027	0.165	-0.162	.871	-0.352	0.299	.000
	PEDS*	-0.398	0.031	-12.766	.000	-0.459	-0.336	.541

\*Significant at  $\alpha = .05$ ,  $p < .001$ .

The parameter estimates (Table 11) show that the linear relationship between GHSGT and the composite of EXPPP, TEACHQLT, PEDS had an overall  $R^2 = .698$  with  $Adjusted R^2 = .691$ , explaining 69.1% of the multivariate linear association. The coefficients of the regression lines were  $\beta = -.002$  for EXPPP;  $\beta = -.057$  for TEACHQLT; and  $\beta = .524$  for PEDS.

The linear multivariate regression model for GHSGT may then be written as:

$$GHSGT = 90.698 - .002EXPPP - .056TEACHQLT - .524PEDS.$$

Since the slopes of EXPPP and TEACHQLT are not statistically significant, the regression model was run with PEDS as the only input variable, the linear regression model can be more correctly written as:

$$GHSGT = 86.464 - .524PEDS$$

The linear relationship between HOPE and the composite of EXPPP, TEACHQLT, PEDS, has an overall  $R^2 = .561$  with an  $Adjusted R^2 = .552$ , explaining 55.2% of the multivariate linear association. The weights of the regression lines were  $\beta = -.004$  for EXPPP;  $\beta = -.027$  for TEACHQLT; and  $\beta = -.398$  for PEDS. The linear multivariate regression model for HOPE may be written as:

$$HOPE = 86.545 - .004EXPPP - .027TEACHQLT - .398PEDS$$

Since the weights of EXPPP and TEACHQLT were not statistically significant, the linear regression model can be more correctly written as:

$$\text{HOPE} = 73.885 - .403\text{PEDS}.$$

This section has presented the hypotheses, the methods used to test the hypotheses, and the results of those tests. This study has (1) established the differences between school districts on the composite of input and output measures, (2) established the strength of the relationship between the linear composite of a set of input variables and the linear composite of a set of output measures, and (3) established the linear regression models that maximized the relationship between the educational input variables and the output measures. The next section presents a discussion of the findings.

## Discussion

In this study, multivariate methods were used to accommodate the multivariate nature of educational input and output measures. The economic status of students was treated both as an integral part of the education input-output mix and as a controlling factor. When treated as an integral part of the input-output mix, the positioning of the economic status of students receives deserved attention with wider implications for performance and achievement assessment in education. Klick (2000) argued for the inclusion of socioeconomic status of students as an educational input, stating that the background economic status of a student is a significant determinant of educational success.

The variable that most significantly separated the districts was the economic status of students (PEDS). Other education production variables, like expenditure per pupil and student achievement, were important only after the economic status of students was first taken into consideration. The school districts in this study were greatly separated on an economic basis, possibly akin to the *de facto* segregation of school districts on racial lines as identified by Coleman et al. (1966). This economic *de facto* segregation may influence some other factors that impact student achievement. Significant variations in SES measures are usually characteristic of heterogeneous urban-suburban communities (Aaronson, 1999) similar to the ones in which the school districts used for this study are located. The significant disparities in the economic status of students across the school districts call for a differentiated educational policy agenda and policy formulation to better reflect the important position of this variable in the education production mix.

After controlling for PEDS, there were statistically significant differences on the combination of input and output variables, particularly expenditures per pupil, achievement, and teacher quality. This finding suggests that greater funding for high schools, and in this particular case for science education, would positively impact success on the GHSGT and improve student grades in science class and perhaps increase eligibility for HOPE. Other education productivity researchers (Alexander, 1997; Figlio, 1999; Hanushek, 1986, 1989, 1991; Mancebon & Bandres, 1999; Monk, 1992; Walberg, 1982) also found that money is important in education when SES is removed from the production equation. Hence, we can say that money matters, when the socio-economic background of students is considered as an input.

The differences in per pupil expenditure between districts may be due to the differential weights attached to various categories of students based on types of educational programs offered and the profiles of the teachers. Moreover, higher per pupil expenditures may indicate a greater number of special needs students. In addition, QBE funding includes the cost of teachers'

salaries and benefits. Moreover, higher expenditures per pupil may also be a result of teachers with more training and/or experience.<sup>4</sup>

The results showed an inverse relationship between expenditure and achievement in that the highest per-pupil-spending district was not the best performing district nor was the lowest per-pupil-spending district least performing district on the two achievement measures, indicating that factors other than or in addition to money determine student achievement.

The index developed to measure teacher quality may not be adequate to demonstrate variability across the six school districts. The measure did not include consideration for science teachers who actually teach the subjects in their specialized areas such as physics, chemistry or biology, and those who do not. However, this index moves beyond the proxies for teacher quality in education production studies that have used years of experience, highest qualification or salary, considered separately (Figlio, 1999; Firestone 1991; Goldhaber & Brewer, 1997, Goldhaber, et al., 1999). Incorporating other indicators, such as in-field teaching experience and classroom practices, into the teacher quality measure may produce a more robust proxy for teacher quality.

After controlling for PEDS, three school districts had higher teacher quality indices than the school with the highest teacher quality index before the adjustment, indicating a relationship between PEDS and teacher quality. The school districts with high PEDS tended to have teachers with either more years of experience and/or higher academic qualifications. The implication of this finding is discussed further when the relationships between the variables are discussed.

The school districts with relatively high teacher quality and a high percentage of economically disadvantaged students also had significantly lower percentages of students passing the GHSGT at first sitting. The 22.53% differential in performance scores between the highest and the lowest scoring school districts is of practical significance as this may translate into the percentage of potential graduates in the lowest achieving school district who could not graduate because they did not pass the science section of GHSGT. These students may need additional educational services, placing an additional burden on the financial resources these districts. A closer study and examination of possible cause(s) of the differences between school districts on this performance measure is not only necessary but also imperative.

The school district with the lowest percentage of students passing the science section of the GHSGT at first sitting also had a significantly lower percentage of HOPE scholars. The difference of 18.83% between the district with the highest and the lowest HOPE percentage is of practical significance. Since the HOPE scholarship provides free tuition and books to any public university in Georgia, the opportunity for postsecondary education and a way out of the cycle of poverty through higher education cannot be realized by many of the very students who might benefit the most. Therefore, the great disparities in the percentage of potential HOPE scholars across school districts should be a policy concern and an item on the education agenda.

After controlling for the effects of PEDS and adjusting GHSGT and HOPE, the lowest performing school district became the highest performing school district on these two output measures. In fact the, the two highest performing school districts before the adjustment became the two worst performing school districts on the HOPE measure, after the adjustment. This finding has relevance in school performance reporting to the public.

Georgia's Office of Student Achievement (GOSA) provides annual district and school report cards. OSA does not statistically control for the effect of the percentage of economically disadvantaged students before reporting student performance on standardized tests. GOSA disaggregates achievement measures on the basis of race, gender, and PEDS; however,

disaggregating on the basis of these factors is not the same as statistically controlling for these factors. Disaggregation is simply a classification process, while statistical control is an equalization process. A reporting system that provides more objective performance information about schools and school districts is necessary.

Moreover, the current way of reporting education performance disregards the possible value-added gains some schools with high percentages of economically disadvantaged students make in student achievement while unfairly rewarding the gains of schools with low percentages of economically disadvantaged students. Furthermore, practices such as moving students from the supposedly “low-performing” schools to supposedly “high-performing” schools, as called for by the No Child Left Behind (NCLB) Act, could be a recipe for misplaced judgment. Such practices may produce the exact opposite of the intentions of NCLB. The “high performing” schools with low PEDS may lack the necessary ingredients to make value-added gains in educating students from economically disadvantaged backgrounds. Simply moving such students from “low performing schools” to “high performing schools” without paying attention to their particular circumstances, is not a panacea for bridging the achievement gap.

The significant positive relationship between the overall composite of input variables and the composite of the two output measures was defined, in descending order of magnitude and effect, by economic, financial, and achievement considerations. This result again confirms that money matters in education, but only after controlling for the economic status of students.

When each of the variables was considered separately, there was a significant positive correlation between per pupil expenditure and teacher quality. This positive relationship is not surprising. As stated before, the current indicators used for defining teacher quality are based on highest qualification (training) and experience, both of which are used in determining teachers’ salaries and compensation in Georgia. High quality teachers, based on the current indicators, mean higher personnel costs which impacts per pupil expenditures.

The significant positive correlation between teacher quality and the percentage of economically disadvantaged students is a finding contrary to the popular notion that schools with high percentages of economically disadvantaged students have lower quality teachers. In this study, schools with high PEDS tended to have teachers with higher qualifications and higher experience.

The statistically significant positive correlation between GHSGT and HOPE has important practical significance--the higher the GHSGT the higher the HOPE. There is a possibility that students with higher ability in science may significantly increase their chances of qualifying for HOPE. This may imply that school districts that are not doing well in science may be shortchanging their students on HOPE scholarship possibilities and entry into postsecondary education.

The strong negative correlations between PEDS and GHSGT and between PEDS and HOPE reinforces the need to pay more attention to the economic status of students as an integral part of educational input, not just as a controlling factor. The negative correlations also indicate that increased teacher quality and expenditure per pupil does not necessarily increase the percentage of students qualifying for the HOPE scholarship.

There is a positive, but statistically non-significant, correlation between expenditures per pupil and the measures of student achievement, without controlling for PEDS. This finding is consistent with the findings on money and educational achievement (Coleman et. al., 1966; Hanushek, 1997) which contended that increasing overall expenditure (in the presence of the economic background of students) does not necessarily improve student achievement. However,

the findings of this study indicate that on the aggregate, the schools districts that had more money tended to perform better. This is the unresolved dilemma about the relationship of money to education that has been debated for years. While some education funding researchers (Coleman et al., 1966; Hanushek, 1997; Unnever, Kerckhoff, & Robinson, 2000) believe that money does not matter, others (Greenwald et al., 1996; Klick 2000; Mancebon & Bandres, 1999; Monk, 1992; Tatsuka, 1988; Walberg, 1982; Walberg & Fowler, 1989; Walberg & Weistein, 1982; Weglinsky, 1997) believe that money matters.

Realistically, the percentage of economically disadvantaged students is a money issue. If we accept the premise that these students come to school with possible financial deficiencies, and the schools they attend indirectly inherit these financial deficiencies, then the economic status of students should be part of the fiscal educational input.

When the economic background of students is considered as a fiscal input, there is definitely a significant relationship between money and student achievement. This finding that money matters is consistent with the findings of Monk (1992), Greenwald, Hedges, and Laine (1996), Klick (2000), and Hasci (2002).

The findings also indicate a significant positive linear relationship between the overall composite of the input variables and the composite of the two output measures. However, the linear models were mostly defined by PEDS. Therefore, the significant regression model equations developed for the two output variables were:

$$\begin{aligned} \text{GHS GT} &= 86.464 - 0.524\text{PEDS} \\ \text{HOPE} &= 73.885 - 0.403\text{PEDS} \end{aligned}$$

The practical implications of this finding is that if there were no economically disadvantaged students in these high schools, 86.464% of the students could pass the science section of the GHS GT at first sitting and 73.885% of the graduating students could qualify for the HOPE scholarship. The results indicated that a 1% increase in PEDS may produce a 52.4% decrease in the percentage of students passing the science section of the GHS GT and a 40.3% decrease in the percentage of graduating students qualifying for the HOPE scholarship. Using the data from Table 2, the 55.92% (66.31-10.39) difference in PEDS between the school district with the highest PEDS and the school district with the lowest may potentially produce a 29.30% (0.524 x 55.92) difference in GHS GT, and a 22.54% (0.403 x 55.92) difference in HOPE. The practical implications of this possible difference in the measures of student achievement may translate into a strain on the financial resources of schools with high PEDS and the future of the students these schools serve.

In conclusion, the findings of this study indicated that money matters as a determinant of student achievement when the economic status of students is considered as an integral part of the educational output mix. The findings also reside with other studies that found an ambivalent and inconclusive relationship between money and student achievement.

This study makes the following significant contributions to the education production field:

- The use of multivariate methods that incorporated the simultaneous use of multiple educational inputs and outputs.
- These methods emphasize the inherent multi-faceted nature of education productivity.
- The development and use of a teacher quality proxy that combined two commonly used indices that have been treated separately in other studies.
- The incorporation of the economic status of students as both an integral part of the educational input mixes and as a controlling variable.

The findings of this study also raise issues of teacher quality and the impact on student achievement. NCLB's definition of a highly qualified teacher and the proxies used in determining teacher quality are beginning steps in capturing what makes a highly qualified teacher. Credentials and years of service are used because those data are readily available as are test scores. And as stated earlier, being certified to teach high school science most likely does not mean that the teacher is expert in biology, chemistry, earth sciences, physics, etc. even those the teacher may be assigned to teach in all those areas. Making money matters in science means the availability of equipment and the availability of appropriate professional development for teachers.

Rothstein, in his book *Class and Schools* (2004) tells us that even if all teachers were highly qualified they could not close the achievement gap. Rothstein argues that until conditions over which schools have no control are rectified, there will be an achievement gap. Those conditions include good pre-natal care, continuing medical care, the affordability of optical and dental services as well as proper food and shelter. Although Coleman's work (1968) incensed the education community 40 years ago, evidence over time now indicates that SES and home environment play significant roles in student learning an achievement.

The findings also showed that some schools that are already achieving could be doing better. While it is important that educators try to raise all students to a certain standard, that is not enough if students who have great potential are not achieving above the minimum standards. The ways of reporting how well students are doing academically need to be examined by policy makers so that these reports reflect gains over time, based on set expectations. While state mandated standardized tests are necessary to provide overall measures of the level of proficiency attained by students in a given curriculum, emphasis should also be placed on the formative assessments leading to these standardized tests. The formative assessments can be given assigned weights to count as fractional parts of the state mandated standardized tests to reflect students' academic growth over time.

## References

Aaronson, D. (1999). The effects of school finance reform on population heterogeneity. *National Tax Journal*, 52 (1), 5-29. Available: <http://search.epnet.com/login.aspx?direct=true&db=buh&an=1743056>

Alexander, K. L. (1997). Public schools and public good. *Social Forces*, 76 (1), 1-30.

Clotfelter, C.T., & Ladd, H. F. (1999). Recognizing and rewarding success in public schools. In H. F. Ladd (Ed.), *Holding schools accountable: Performance-based reform in education* (pp23-63). Washington D.C: Brookings Institute.

Coleman, J. S. (1968). The concept of equity of educational opportunity. *Harvard Educational Review*, 38 (7), 7-22.

Coleman, J. S., Campbell, E. Q., Hobson, C. J., McPartland, J., Mood, M. M., Weinfeld, F. D., & York, R. L. (1966). *Equity of educational opportunity*. Washington, D.C: U.S. Government Printing Office.

Coleman, P., Easton, S., & LaRocque, L. (1998). Reconciling equity and excellence: Resource allocation in school districts. In W. T. Hartman & W. L. Boyd (Eds.), *Resource allocation and productivity in education* (pp 101-128). Westport, CT: Greenwood.

Cox, R.D. (1958). *Planning of experiments*. New York: Wiley.

Dolan, R. C., & Schmidt, W. (1987). Assessing the impact of expenditure on achievement: Some methodological and policy consideration. *Economics of Education Review*, 6(3), 285-299.

Available:

[http://www.sciencedirect.com/science?\\_ob=PublicationURL&\\_toctype=%23TOC%235921%231987%23999939996%23291300%23FLP%23&\\_cdi=5921&\\_pubType=J&view=c&\\_auth=y&\\_acct=C000033918&\\_version=1&\\_urlVersion=0&\\_userid=655127&md5=0598d29aee6e097cd21bf76ffd97a013](http://www.sciencedirect.com/science?_ob=PublicationURL&_toctype=%23TOC%235921%231987%23999939996%23291300%23FLP%23&_cdi=5921&_pubType=J&view=c&_auth=y&_acct=C000033918&_version=1&_urlVersion=0&_userid=655127&md5=0598d29aee6e097cd21bf76ffd97a013)

Figlio, D. N. (1999). Functional form and estimated effects of school resources. *Economics of Education Review*, 18, 241-252.

Firestone, W. A. (1991). Merit pay and job enlargement as reforms: Incentives, implementation, and teacher response. *Educational Evaluation and Policy Analysis*, 13 (3), 269-288.

Georgia Department of Education (2002). *2000-2001 Georgia public education report card, State of Georgia*. Atlanta, GA: Office of Educational Accountability, GA Department of Education.

Georgia Department of Education (2003). *2001-2002 Georgia public education report card, State of Georgia*. Atlanta, GA: Office of Educational Accountability, GA Department of Education.

Georgia HOPE scholarship program. (1997, February). Georgia HOPE scholarship program: Good intentions, strong funding, bad design. *Copy Postsecondary Education Opportunity Editor*, 12-14.

Goldhaber, D. D., & Brewer, D. J. (1997a). Why don't schools and teachers seem to matter? Assessing the impact of unobservables on education productivity. *Journal of Human Resources*, 32, 505-523.

Goldhaber, D. D., & Brewer, D. J. (1997b). Evaluation the effect of teacher degree level on education performance. In W. Fowler (Ed.), *Developments in School Finance, 1996* (NCES 97-535) (pp. 197-210). U.S. Department of Education, NCES. Washington, DC: U.S. Government Printing Office.

Goldhaber, D. D., Brewer, D. J., & Anderson, D. J. (1999). A three-way error component analysis of education productivity. *Education Economics*, 7(3), 199-208. Available: [http://eric.ed.gov/ERICWebPortal/Home.portal?\\_nfpb=true&\\_pageLabel=RecordDetails&ERICExtSearch\\_SearchValue\\_0=EJ597060&ERICExtSearch\\_SearchType\\_0=eric\\_acno&objectId=0900000b8001cad6](http://eric.ed.gov/ERICWebPortal/Home.portal?_nfpb=true&_pageLabel=RecordDetails&ERICExtSearch_SearchValue_0=EJ597060&ERICExtSearch_SearchType_0=eric_acno&objectId=0900000b8001cad6).

Greenwald, R., Hedges, L. V., & Laine, R. D. (1996). The effect of school resources on student achievement. *Review of Educational Research*, 66(3), 361-396.

Hanushek, E. A. (1971). Teacher characteristics and gains in student achievement: Estimation using micro-data. *American Economic Review*, 6 (2), 280-288.

Hanushek, E. A. (1981). Throwing money at schools. *Journal of Policy Analysis and Management*, 1 (1), 91-41.

Hanushek, E. A. (1986). The economics of schooling: Production and efficiency in public schools. *Journal of Economic Literature*, 24, 1141-1178.

Hanushek, E. A. (1989). The impact of differential expenditures on school performance. *Educational Researcher*, 18 (4), 45-65.

Hanushek, E. A. (1991). When school finance reform may not be a good policy. *Harvard Journal of Legislation*, 28, 423-456.

Hanushek, E. A. (1996). School resource and student performance. In, G. Burtless (Ed.). *Does money mater: Effect of school resources on students achievement and adult success* (pp 43-73). Washington, DC: Brookings Institute.

Hanushek, E. A. (1997). Assessing the effects of school resources and student performance: An update. *Educational Evaluation and Policy Analysis*, 19, 141-164.

Hasci, T. A. (2002). *Children as Pawns: The politics of education reform*. Cambridge, Massachusetts: Harvard University Press.

Hedges, L.V., Laine, R. D., & Greenwald, R. (1994). Does money matter? A meta-analysis of studies of the effects of different school inputs on student outcomes. *Education Researcher*, 23(3), 5-14.

Heinbuch, S. E., & Samuels, J. A. (1995). Getting more bang for the education buck. *Public Productivity & Management Review*, 18(3), 233-242. Available:

<http://www.jstor.org/view/10448039/ap060023/06a00030/0>

Klick, J. (2000). Do dollars make a difference? The relationship between expenditures and test scores in Pennsylvania's schools. *American Economist*, 44(1), 81-87. Available: <http://search.epnet.com/login.aspx?direct=true&db=buh&an=3138079>.

Mancebon, M., & Bandres, E. (1999). Efficiency evaluation in secondary schools: The key role of model specification and of ex post analysis of results. *Education Economics*, 7(2), 131-152.

Monk D. H. (1992). Education resources for improving schools: A case study of teacher allocation in Boston Public Schools. *Education Evaluation and Policy Analysis*, 14(4), 307-332.

Montmarquette, C., & Majseredjian, S. (1989). Does school matter for educational achievement? A two-way nested error component analysis. *Journal of Applied Economics*, 4, 181-193.

Mortimore, P., Simmons, P., Stoll, L, Lewis, D., & Ecob, R. (1988). *School matters: The junior years*. Somerset: Open Books.

Murnane, R. (1975). *Impact of school resources on the learning of inner city children*. Cambridge, MA: Ballinger.

Official Code of Georgia Annotated. (1996). *OCGA*, 20-2-281.

Official Code of Georgia Annotated. (2000). *OCGA*, 20-14-25.

Pedhazur, E. J. (1997). *Multivariate regression in behavioral research: Explanation and prediction*. 3<sup>rd</sup> Ed. Toronto, Ontario: Wadsworth.

Rothstein, R. (2004). *Class and Schools*. Washington, DC: Economic Policy Institute.

Smith, D., & Tomlinson, S. (1989). *The school effect: A study of multi-racial comprehensives*. London: Policy Studies Institute.

Tatsuoka, M. M. (1973). Multivariate analysis in education research. In F. N. Kerlinger (ed.), *Review of research in education*, 1 (pp. 273-310). Itasca, IL: Paacock.

Tatsuoka, M. M. (1988). *Multivariate analysis: Techniques for educational and psychological research*. New York: Macmillan.

Unnever, J. D., Kerckhoff, A. C., & Robinson, J. J. (2000). District variations in education resources and student outcomes. *Economics of Education Review*, 19(3), 245-259.

U. S. Department of education, NCES. (2003a). *Digest of Education Statistics 2003*. Available: <http://www.nces.ed.gov/programs/digest>

U. S. Department of education, NCES. (2003b). *Overview of public elementary and secondary schools and districts: School year 2001-2002* (NCES 2003-346). Washington, DC: U.S. Government Printing Office. Author.

Walberg, H. J. (1982). Education productivity: The theory, evidence, and prospects. *Australian Journal of Education*, 26(2), 115-122.

Walberg, H. J., & Fowler, W. J. (1989). Expenditure and size efficiencies of public school districts (Report No. RC-015-786). East Lansing, MI: National Center for Research on Teacher Learning. (ERIC Document Reproduction Service No. ED 274471).

Walberg, H. J., & Weinstein, T. (1982). The production of achievement and attitude in high school social studies. *Journal of Educational Research*, 75(5), 285-292.

Wenglinsky, H. (1997). School district expenditures, school resources, and student achievement: Modeling the production function. In W. J. Fowler (ed.), *Developments in School Finance, 1997-1998* (pp. 99-120). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

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<sup>1</sup> For the school years of this study, the state prepared school level allotment sheets. The practice began with major reforms in education in Georgia including mandated school site councils but was stopped after those two years.

<sup>2</sup> The dollars used in this study are lower than might be expected because the QBE formula represents direct instruction dollars and some instructional support. National statistics include expenditures to all expenditures including transportation, administration, and all other costs. The Georgia measure isolates expenditures for the classroom. The high school cost is based on a class size of 23 students.

<sup>3</sup> Most studies refer to the economic condition of students as SES or socio-economic status, but then rely on the eligibility for federal free and reduced lunch prices as a proxy. We have chosen to use the term PEDS since FRL eligibility is based on current family income.

<sup>4</sup> The QBE also pays teacher salaries based on the State Minimum Salary schedule. Had there been a wider variation of teacher quality, as indicated by the index based on experience and degrees, one might argue that teacher salaries might be responsible for the variation in per pupil expenditures. However, the teacher quality index did not use dollar amounts.