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ABSTRACT

The education-production function has become the dominant paradigm for analyzing the effects of education resources on student outcomes. This paper presents findings of a study that investigated the education-production function and its relationship to educational policymaking. Fiscal data and student-achievement test scores for Indiana during the 1993-94 school year were analyzed using Fortune and O'Neil's (1994) methodology as an alternative to traditional production-function analysis. The model uses t-tests for determining significance and comparing homogeneous subgroups. Although the alternative methodology is more likely to reveal relationships between inputs and outcomes, the Indiana data revealed no significant relationships between expenditures and student achievement. However, when analysis of socioeconomic status and student achievement was conducted, there was a high correlation between these variables. Fortune and O'Neil concluded that the only constitutionally relevant outcome of education is whether or not students receive equal access to state resources. This study demonstrates that all students in Indiana do not have equal access to resources. One problem with production-function analysis is that it assumes that all schools pursue the same goals and that the goals are related to student achievement. Second, production-function analysis inadequately identifies inputs and ignores processes. For example, production-function analysis overlooks curriculum and instruction as an input. A conclusion is that increased revenues must be used to find new strategies for improving student achievement. Five tables are included. (Contains 14 references.) (LMI)

An Indiana Investigation of the Impact of Expenditures & Socioeconomic Status on Student Achievement: Does Money Matter?

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Abstract

This study investigates the education production function and discusses its relationship to educational policymaking. Fiscal data and student achievement test scores for Indiana during the 1993-94 school year are used in the production function analysis. The research methodology is different than traditional production function analysis; an alternative methodology proposed by Fortune & O'Neil (1994) using t-tests for significance and comparing homogeneous subgroups was adopted for this study. Although the alternative methodology is more likely to reveal relationships between inputs and outcomes, the Indiana data revealed no significant relationship between expenditures and student achievement. However, when analysis of socioeconomic status and student achievement was conducted there was a high correlation between these variables. The utility of education production function analyses in policy formulation and decision making is considered, especially in light of the results of the Indiana investigation.

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Introduction and Background

In the wake of the national educational reform bill, Goals 2000: Educate America Act, the question of whether allocating and spending more money on education will actually increase student productivity arises in policy discussions. Odden (1994) indicates that even before the recent focus on higher student achievement, the realization that funding has been substantially increasing while student achievement has remained flat has led some to the conclusion that education has a productivity problem. The prospect of spending more money on education nationally and within states generates controversy because researchers have contrary findings (e.g. Hanushek, 1989; Monk, 1989; Baker, 1991; Card & Krueger, 1992; Wainer, 1993; and Hedges, Laine, & Greenwald, 1994a, 1994b) concerning whether differential school inputs actually influence student outcomes. The more technical term for this type of research is education production function analysis.

Over the last decade the education production function has become the dominant paradigm used to analyze the effects of education resources on student outcomes (Greenwald, Hedges, & Laine, 1994). Production function studies attempt to develop a model of the relation between educational inputs and outcomes. Greenwald, Hedges, & Laine define inputs to include school resources such as expenditures, teacher characteristics, or facilities, and student characteristics such as socioeconomic status or ability. They define outcomes as achievement as measured by standardized tests, future educational patterns, and adult earnings. Furthermore, the goal of production function studies is to develop quantitative models that can predict the effect on student outcomes of a given change in inputs. Therefore, in theory a production function could predict how much the median achievement on a standardized test would change if for example, per-pupil expenditures were increased by $500 (Greenwald, Hedges, & Laine). They also point out that although there is no consensus on the exact specification of the educational production function, there are broad guidelines regarding the specification of models, and more specifically, on measures of school resources, student characteristics, and outcomes.

Although education production function is considered a viable research method for analyzing resource inputs and educational outcomes, there is controversy concerning its methodology and the policy relevance of its results. For example, in a meta-analysis of 187 studies using production function methodology Hanushek (1989) concluded that there is no systematic relationship between resource inputs and school outcomes when controlling for students characteristics and socioeconomic status. Hedges, Laine & Greenwald (1994a) contend that the method Hanushek employed in his meta-analysis, vote-counting, is weak as an inference procedure and has low statistical power. Instead, their meta-analysis of the same studies using more sophisticated synthesis methods (i.e. combined significance tests and estimation methods) shows systematic positive relations between resource inputs and school outcomes. Hanushek (1994) responds to Hedges et al. (1994a) by defending his previous conclusions and arguing that "policy makers should not be confused into believing that throwing money at schools in effective" (p. 8). In response, Hedges et al. (1994b) defend their research methodology and support their conclusions that there is a positive relationship between resources and school outputs and contend that the focus should now shift to how money matters.

Fortune & O'Neil (1994) also illuminate problems with the production function approach and Hanushek's (1989) conclusions and contend that correlational methods for analysis may hide rather than reveal relationships. They propose the use of t-tests for significance as an alternative method for analysis of expenditure and achievement data. For example, by examining homogeneous sets of school districts based on the key dimension of wealth and conducting several t-tests for significance, possible relationships between expenditures and achievement that were overlooked by the traditional production function method are exposed.

Considering the controversy surrounding traditional education production function research described above, the research we conducted attempts to replicate the methodology proposed by Fortune & O'Neil (1994). Their alternative production function methodology is applicable if the policy question of interest is whether differences in funding relate to current differences in test scores. Since educational funding equity and revision of Indiana's school funding formula are prevailing policy issues we decided to use the alternative production function methodology to investigate whether differences in funding are related to differences in test scores. We use achievement test data for the state Indiana (Indiana Statewide Educational Testing Program - ISTEP) and compare it with school district per pupil expenditures to determine if significant differences in achievement exists between high spending and low spending districts. We also expanded our investigation and examined socioeconomic status (SES) as a student input characteristic (Greenwald, Hedges & Laine, 1994) and compared it with district ISTEP scores. Further, we examine the limitations of our research and discuss the implications of our findings for policy makers using production function research to formulate educational policy.

Methodology

Fortune and O'Neil (1994) levy an attack on the appropriateness of production function research to assess educational funding equity. Their critique centers around methodological limitations, including the incorrect use of correlational methods, attenuated variables, and shared variance issues associated with multiple regression techniques. They also point out that the methodological problems limit its usefulness for policy research. In order to make the production function approach policy relevant, they alter the production function analysis in three ways. First, they contend that the task should be a comparison rather than an association. Second, rather than looking for a consistent relationship across the whole population, they believe it is better to ask for what kinds of districts such effects exist within a state. The third alteration is to create a discrepancy in expenditures large enough to expect differences in the purchasing power of educational services.

Since a multitude of problems exist with the traditional method of production function analysis, we adopted Fortune and O'Neil's (1994) alternative production function methodology to study the educational funding equity in public schools in Indiana. More specifically, we have investigated "the only question truly addressed by productio: unction studies:" (Fortune & O'Neil, 1994, p. 22) Are differences in per pupil expenditures associated with differences in achievement test scores? We analyzed test score data from Indiana's elementary schools and general fund expenditure data from the corresponding school districts. The test score data is from Indiana's Statewide Test of Educational Progress (ISTEP), a test which is taken each year in Indiana by students in grades two, three, six, and eight. Mandatory summer remediation classes (known as Extended Learning Program) are required for students whose ISTEP scores fall below a statewide cutoff score (Indiana Education Policy Center, 1994).

Statistical data was obtained from the Indiana State Department of Education by downloading it from Ideanet, the Department of Education's computer system (Internet node) designed to provide a variety of educational data to school systems and universities within Indiana. The following data were collected for all public schools within the state: SES(socioeconomic status), ISTEP total battery (Indiana Statewide Test of Educational Progress), ISTEP language proficiency, ISTEP mathematics proficiency, district general fund expenditures, and ADM (Average Daily Membership). All data were for the 1993-94 school year.

All elementary schools were grouped by district. In order to create homogeneous subgroups for analysis, outliers within the sample were deleted from the data set. These outliers included (a) all schools which were designated as strictly special education centers, (b) all schools designated as vocational education centers, (c) all school districts in excess of 25,000 students, and (d) all school districts with fewer than 300 students. Additionally, a district with an extremely low general fund expenditure was deleted, due to our belief that the data point was clearly erroneous in comparison to the other data.

Per pupil expenditures were calculated by taking the general fund expenditures (the only expenditure category available on the database) reported for the district and dividing by the district's reported Average Daily Membership (ADM). This quotient is the value reported for per pupil expenditures throughout this study. According to Fortune & O'Neil (1994), the data should be ordered by instructional expenditures per pupil and then divided into two equal groups--the upper and lower 30 percent of the sample. They also require that a disparity of at least $700 between districts be established. This figure is based on the amount of money (prorated) that a 1970 study established as what was needed to improve elementary school student's reading scores by a one-month-of-training-experience level over the course of a year. In our data set a funding threshold of $893.86 was established; the difference between the average of the upper 30% of the elementary sample and the average of the lower 30% of the elementary sample. This value clearly exceeds the $700 disparity between homogeneous subgroups suggested by Fortune and O'Neil. The per pupil expenditure data was calculated on a per district basis, which meant that ISTEP scores had to be averaged for all the elementary, middle, and high schools in that district. It was this average that was used as the district ISTEP score. The ISTEP scores are T-scores.

Independent t-tests with pooled variance were then used to check for significant differences between ISTEP test scores between the previously mentioned upper and lower samples. The means, variance, number of schools, districts, P values and significance at the $\alpha = .05$ level are reported in the tables that follow in the next section.

Results

The results of this study indicate that there is no significant difference in elementary student achievement scores (as measured by the ISTEP) based on per pupil expenditures. Using the upper and lower 30% of the educational expenditures to establish the two groups, a funding threshold of $893.86 separates the average expenditure of the groups. Fortune and O'Neil (1994) suggest that this should be, within a single homogeneous subgroup, capable of demonstrating differences in achievement scores. We did not find this to be the case with our sample.

Our results are displayed in Table 1. A total of 170 districts make up the upper and lower 30% of the total elementary sample. Comparison of the 85 districts in the lower 30% of the sample to the 85 districts in the upper 30% of the sample demonstrates no significant difference in mean ISTEP test scores on either the total battery, the language proficiency, or the mathematics proficiency sections. In fact, in all cases, the higher expenditure districts actually had slightly lower test scores and much greater variation among scores than the lower expenditure districts. This result may be due in part to the fact that general fund expenditures include the state basic grant revenue for special education, vocational education, at-risk, and categorical grants. Also included in the general fund are other state grants for summer school, adult education, gifted and talented, ISTEP, performance based awards, textbook reimbursement, social security, and PRIMETIME. Capital outlay and debt service are not included in general fund revenues. Therefore, it is possible that the "mix" of grants for "at-risk students" included in general fund expenditures creates districts with high expenditures that have a "mix" of student abilities, many of whom are low achievers. This could explain the lower mean scores and greater variance in scores than their lower expenditure counterparts.

[Insert Table 1 about here]

Believing that perhaps an inadequate funding threshold had been established, we conducted t-tests for the upper and lower 15% of the sample. As shown in Table 2, this creates a funding threshold of $1304.75. The results of the t-tests for those 84 districts still demonstrated no significant difference between the two groups.

[Insert Table 2 about here]

When simple Pearson correlations were run for the entire data set, it was determined that the highest correlations existed between SES and ISTEP scores. In fact, the correlations were on the order of 0.73 on average. Other interesting, non-zero, correlations exist between SES and attendance ($r=0.72$) as well as between attendance and ISTEP scores ($r=0.60$). Since socioeconomic status (SES) is a student characteristic that is considered an input measure (Greenwald, Hedges, & Laine, 1994) an analysis of ISTEP scores against SES data was undertaken. Table 3 demonstrates the results which were obtained using this comparison.

[Insert Table 3 about here]

The data for these t-tests were obtained in a similar manner to the recommendations of Fortune & O'Neil (1994). All elementary schools were ordered by increasing socioeconomic status (SES) values. SES, as defined by the Indiana Department of Education, is the percentage of students not on free or reduced lunch programs. An SES of 0.950 means that 5 percent of the students are on free or reduced lunch programs at that school. Once the schools were ordered by increasing SES, two groups were established by taking the upper and lower 30% of the total sample now based on SES.

The results indicate that the high SES school districts scored significantly better than the lower 30% group on the three reported achievement measures of the ISTEP test (battery, language, math). The large n in this sample (n=347) is due to the fact that SES was reported for each school along with the schools' individual ISTEP scores. Therefore, no across-district averaging was necessary as it was when using PPE as the input variable.

The results of this comparison demonstrate the significant differences between high and low SES districts. The overall total battery on the ISTEP shows a difference of nearly 12 points between the upper and lower groups based on SES. The language and mathematics subtests showed approximately a 17 and 16 point difference respectively. One need not even bother with t-tests to determine that significant difference exists between the two groups.

Since elementary schools revealed such an obvious difference between upper and lower groups, it was decided that middle school and high school data should also be evaluated using this methodology. The middle school data is shown in Table 4. The same variables as the elementary data are evaluated.

The high school data is shown in Table 5, and includes additional comparisons to SAT data and graduation rate data for low and high SES student populations.

[Insert Tables 4 & 5 about here.]

Again, both the middle school and high school data suggest that large differences exist between the lower and upper 30% of each sample based on socioeconomic status (SES). Effectively a 19 point difference exists between the lower and upper groups on the language proficiency portion of the ISTEP for the middle school students. A 12 point difference exists for the lower and upper groups on language proficiency for the high school students. Similar results are obtained for the total ISTEP battery and math proficiency sections, with the higher SES group consistently outscoring, by a substantial margin, their lower SES counterparts.

When we focus on the additional high school independent variables of SAT scores and graduation rates, we find similar results. The SAT scores of the high SES group are on average 54 points higher than the low SES group. While the difference in points is perhaps not remarkable, it should be kept in mind that the sample of students taking the SAT is significantly reduced from the sample of students who are required to take the ISTEP. The group electing to take the SAT is much more homogeneous than the population which is required to take ISTEP.

The variation in graduation rates at the high school level is cause for concern. According to our data, the lowest 30% of our students based on SES have a 10% lower graduation rate than the highest 30%. In a democracy in which we purport to offer equal educational opportunities to all students, we are clearly falling short of that mark.

Limitations

This analysis is plagued by many of the errors inherent in production function analyses. First, the study is based on aggregated data. The per pupil expenditures are determined at the district level, not by each individual school or program. Therefore, it is impossible to determine if certain schools within a given school district receive differential per pupil expenditures. Also, the availability of general fund expenditures in the data set, rather than instructional expenditures limits the accuracy of the per pupil expenditure figures. Likewise, the ISTEP scores are also aggregated data. In districts with multiple elementary schools, the ISTEP scores for all schools were averaged, and the mean score reported as the district ISTEP score for the battery, language, and/or math proficiency. Monk (1992) recommends that future analyses focus on the classroom as the unit of analysis. Determining per pupil expenditures, socioeconomic status and other independent variables on a classroom by classroom basis and comparing it with educational outputs from the same classrooms is a potentially valuable research endeavor.

In this study, socioeconomic status is clearly a variable which is impacted by many other intervening variables. Socioeconomic status includes a variety of other variables which are not separated out in this analysis, such as stability of the home, educational level of the parent(s), or percentage of adults below the poverty line in the district among others. Clearly, shared variance is a problem in this analysis, and effects the true relationship between the inputs and outputs, as it does in all production function studies of this nature (Fortune & O'Neil, 1994).

Discussion and Conclusions

A primary responsibility of policy makers is to ensure efficient use of taxpayer dollars. Consequently, when research reveals that spending more money on education does not yield significant gains in student achievement, policy makers begin to seriously question or completely reject requests for additional funding of K-12 schools. Sadly, even using the alternative production function methodology proposed by Fortune & O'Neil (1994) the expenditure and achievement test data for Indiana yields this result. Our nonsignificant results demonstrate Fortune & O'Neil's conjecture that production function analysis is "inappropriate for the determination of school funding equality because it attempts to link inputs with one or a few particular output(s) of the education process such as test scores" (p. 22). Furthermore, "the production function methodology ignores and detracts from the fundamental issue of equal access by students to the resources of the state system of education" (Fortune & O'Neil, p. 22). They conclude that the only constitutionally relevant outcome of education is whether or not students receive equal access to the resources of the state. Clearly, our analysis using socioeconomic status (SES) as an input variable and student achievement as the outcome variable demonstrates that all students in Indiana do not have equal access to resources.

Production function research is widely shared with policy makers as evidence that spending more money on education does not increase student achievement. However, policy makers must be made aware that there are several reasons why this type of research has been relatively unsuccessful in identifying relationships between resources inputs and student achievement that are not methodological in nature. Odden & Picus (1992) identify several problems with production function analysis. First, the assumption is made that all schools are pursuing the same goals and that the goals are related to student achievement. This may not be true. Schools pursue many goals and student achievement may not be the primary one. Also, they point out that standardized achievement tests are not necessarily indicators of what students have learned in school.

Another problem Odden & Picus (1992) associate with production function research is the fact that it is difficult to identify inputs. There is no consensus on the types of input to analyze. In addition, since production function studies attempt to relate inputs to outcomes, they ignore processes. A critical process variable that is overlooked is curriculum and instruction which is certainly a significant factor that is linked to student learning. With this fact in mind, one of the five characteristics in Clune's (1993) conceptual framework for systemic educational policy is regular assessment of educational inputs, outcomes, and processes. Accordingly, student assessment in this model would correspond to curriculum goals. Hence, the current movement toward systemic educational reform would certainly limit the utility of production function research in evaluating how resources influence student achievement.

In conclusion, policy makers should exercise caution when evaluating educational productivity based on production function research. Odden & Picus

(1992) conclude that the message of production function research is not that money does not matter, but rather, "...that if additional education revenues are spent in the same way as current education revenues, student performance increases are unlikely to emerge" (p. 281). Hence, increased revenues must be used to find new strategies to improve student achievement. In the current wave of educational reform, policy makers must determine if increasing student achievement is the ultimate and only outcome they are hoping to accomplish. Perhaps there are other important goals and outcomes that education should seek to instill in students that education production function cannot measure and assess. The task of policy makers then is to design coherent educational policy and implement systemic change in education that will improve rather than impede the system. A daunting task, but one that is already underway.

Table 1

Upper and Lower 30% by Per Pupil Expenditures*

Contrasts of High and Low Funded Districts

ISTEP Test	Mean	Variance	n	t	Significance
Total Battery				0.481	n.s.
--High	65.10	31.13	85		
--Low	65.44	13.46	85		
Language Proficiency				0.645	n.s.
--High	50.67	52.29	85		
--Low	51.28	24.00	85		
Math Proficiency				1.015	n.s.
--High	50.99	60.09	85		
--Low	52.02	26.59	85		

* Indiana Per Pupil Expenditures $3528.99 to $4422.85 (n=292)

Table 2

Upper and Lower 15% by Per Pupil Expenditures*

Contrasts of High and Low Funded Districts

ISTEP Test	Mean	Variance	n	t	Significance
Total Battery				0.638	n.s.
--High	64.75	33.41	42		
--Low	65.44	15.10	42		
Language Proficiency				0.0.913	n.s.
--High	50.00	60.06	42		
--Low	51.32	27.88	42		
Math Proficiency				1.006	n.s.
--High	50.66	64.73	42		
--Low	52.15	27.09	42		

* Indiana Per Pupil Expenditures $3427.94 to $4732.69 (n=292)

Table 3

Upper and Lower 30% by SES Contrasts of High and Low SES Elementary Districts*

ISTEP Test	Mean	Variance	n	t	Significance
Total Battery				-26.8	7.0E-106
--High	69.44	21.82	347		
--Low	57.75	44.28	347		
Reading Proficiency				-26.6	1.57E-99
--High	56.36	30.50	347		
--Low	39.54	109.0	347		
Math Proficiency				-24.9	2.1E-93
--High	56.58	37.40	347		
--Low	40.58	102.2	347		

* (n=1156)

Table 4

Upper and Lower 30% by SES

Contrasts of High and Low SES Middle School Districts*

ISTEP Test	Mean	Variance	n	t	Significance
Total Battery				-16.3	1.49E-34
--High	64.64	14.53	84		
--Low	52.14	34.86	84		
Reading Proficiency				-17.2	5.72E-36
--High	57.93	25.08	84		
--Low	39.44	72.25	84		
Math Proficiency				-15.7	3.94E-32
--High	57.54	26.64	84		
--Low	39.69	82.29	84		

* (n=280)

Table 5

Upper and Lower 30% by SES

Contrasts of High and Low SES High School Districts*

ISTEP Test	Mean	Variance	n	t	Significance
Total Battery				-12.2	1.39E-25
--High	64.04	15.17	102		
--Low	55.79	31.50	102		
Reading Proficiency				-11.3	1.44E-22
--High	54.45	33.70	102		
--Low	42.09	89.07	102		
Math Proficiency				-11.9	1.79E-24
--High	55.22	37.58	102		
--Low	41.88	90.74	102		
SAT				-6.23	1.69E-09
-High	889.95	2365	102		
-Low	835.59	5403	102		
GRAD RATE				-7.89	3.25E-13
-High	0.89	0.003	102		
-Low	0.79	0.013	102		

* (n=340)

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