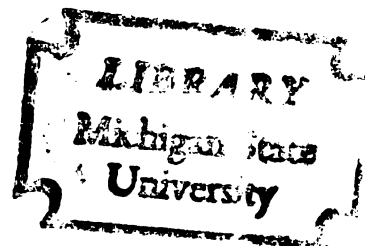


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ABSTRACT

A MULTIPLE OUTPUT APPROACH TO PUBLIC EDUCATION

By

Robert McCartney Leekley

The recent literature in the economics of education suggests that family or community effects dominate, and that the marginal products of school inputs are virtually zero. This study takes the position that such results are based on inadequate models of schools. Most studies have assumed that school output can be represented by a measure of cognitive achievement. Noncognitive outputs are either unimportant, or produced in fixed proportions with the cognitive output. All community types require the same output of their schools; some just succeed more than others. Rejecting such a view of schools, this study develops a multiple output model of education. This model not only acknowledges a wide spectrum of outputs, but predicts that different district types will choose to emphasize different outputs.

The major hypotheses of this study, then, are that schools choose to produce different outputs, consistent with community preferences, and that it is this choice, not differential ability, that leads to the large effects of background factors on individual outputs. The study uses data of the Michigan Educational Assessment Program to test

these hypotheses with a set of production and cost relationships. In addition to "cognitive score," hypothesized output measures include "desire to do well," "self perception" and "liking school."

The results show that some, but not all background effects can be attributed to choice among outputs. Further examination of the background effects remaining in the production functions suggests that they do not represent general differences in the abilities of different groups of children, but rather, very specific differences in their reactions to particular inputs. Finally, the cost function estimate shows that only socioeconomic status affects the output opportunities open to districts for a given expenditure level, and that even this effect is small enough to be offset by state aid of the current magnitude.

A MULTIPLE OUTPUT APPROACH TO PUBLIC EDUCATION

By

Robert McCartney Leekley

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To My Parents

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CHAPTER I

INTRODUCTION

Background and General Approach

As background for our discussion we shall have to remember the role of education in American democratic thought and life. Education has always been the great hope for both individual and society. In the American Creed it has been the main ground upon which "equality of opportunity for the individual" and "free outlet for ability" could be based. Education has also been considered as the best way--and the way most compatible with American individualistic ideals--to improve society.¹

To Gunnar Myrdal, our great, long-standing emphasis on the importance of education is a striking feature of American society. It has long been considered an important guarantor of social mobility and its significance has grown even greater as other guarantors, like the free land of the frontier, have faded into history. To be effective, of course, schools must be able to produce whatever it is that constitutes education and, in fact, they must be effective enough to overcome the disadvantages under which lower class children ordinarily suffer. For years, though, the effectiveness of schools went unquestioned. To Myrdal, for example, it was axiomatic, both that blacks were being subjugated through inferior schools, and that coming improvements in black schools would automatically have profound effects for the place of blacks in American society.

¹Gunnar Myrdal, with the assistance of Richard Sterner and Arnold Rose, An American Dilemma The Negro Problem and Modern Democracy, 2 vols. (New York: Harper and Brothers, 1944), p. 882.

Against such a background, Equality of Educational Opportunity appeared in 1966.² Nicknamed the "Coleman report" after its major author, it represented one of the most ambitious attempts ever to describe public education in America. Apparently even Coleman expected it to show that the differences in achievement among different economic and social groups were largely the result of measurable school inputs.³ However, while confirming the substantially different achievement levels, the report found virtually no difference in the level of school inputs among the various groups. More generally, the report found the level of school inputs to have little or no explanatory power in any case. Family or community attributes dominate; the marginal products of school inputs are virtually zero.

The significance of such a result for the "American Creed" is staggering. As a result, much work has been done, in the years since the Coleman report, to confirm or disprove its findings. Commonly, the estimation of a production function for education is involved. Almost all of this work has used some measure of cognitive achievement as the relevant output. Inputs have included both school attributes, such as class size and teacher qualifications, and family or community attributes, such as socioeconomic status and race. Excepting minor differences, the results have tended to support Coleman's findings.

²James S. Coleman, Ernest Q. Campbell, Carol J. Hobson, James McPartland, Alexander M. Mood, Frederic D. Weinfeld, and Robert L. York. Equality of Educational Opportunity, 2 vols. (Washington, D.C.: U.S. Government Printing Office, 1966).

³James S. Coleman, interviewed in the Southern Education Report (November-December 1965), as quoted by Frederick Mosteller and Daniel P. Moynihan, On Equality of Educational Opportunity (New York: Random House, Inc., 1972), p. 8.

The burden of this study is that these previous results are seriously biased by the exclusion of other outputs. Educators and sociologists agree that schools have many goals besides that of teaching the basic cognitive skills. Quoting again from Myrdal:

The marriage between philosophy and pedagogy in Dewey and his followers has given America the most perfected educational theory developed in modern times. Under the slogan "education for a changing world" and supported by a whole science of "educational sociology," it requires that education be set in relation to the society in which the individual lives. The introduction of this value relation into discussions of educational goals and means is a paramount contribution of America. And this has remained not only an achievement of academic speculation and research but has, to a large extent, come to influence policy-making agencies in the educational field. America has, therefore, seen more of enterprising and experimental progressive redirecting of schools than has any other country.⁴

Myrdal clearly considers the goals of education in America to be different from those in Europe, which, one infers, must be of a more dogmatic cast. Acceptance of the pragmatic social basis for American education, though, requires consideration of a great many nonacademic goals. Along with the "practical" ones oriented toward careers and occupations, goals would presumably include the perpetuation of our political, social and cultural heritage (including what Myrdal calls the "American Creed") and the formation of a positive self-concept within each child. However, since the background characteristics that provide the basis for the preference of one goal over another vary so much among individual communities, the manner in which these goals are balanced will also vary among communities.

The outputs implied by all these goals of education must be included in any measure of the marginal products of school inputs.

⁴Myrdal, op. cit., p. 883.

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Furthermore, assuming that outputs can be produced in variable proportions, explicit allowance must be made for variation in any one output due to choice among outputs as well as to production-possibilities. A model allowing only one output clearly fails to do so. This study offers an alternative, multiple output model of education, and uses it to test the general hypotheses that the marginal products of purchased inputs are significant and positive, and that the seemingly overwhelming community influence operates through the choice of goals and outputs, rather than through differences in production possibilities, the amount of school resources given.

Chapter II develops the theoretical model with which these general hypotheses will be made more precise and testable. The chapter concludes with a summary list of the hypotheses to be tested. Chapter III, introduces the data to be used for these tests. Chapter IV, then, reformulates the hypotheses of Chapter II in terms of specific statistical tests, using the data of Chapter III. Chapter IV ends with a summary list of the transformed hypotheses, parallel to that which concludes Chapter II. Chapter V reports the major results, and assesses their implications. This chapter also ends with a summary, parallel to the previous two, with the results for each hypothesis. The results of this chapter suggest an extension, examining the form of community effects in greater detail; this extension is the subject of Chapter VI. Chapter VII summarizes and concludes the study. Before preceding to Chapter II, though, the remainder of this chapter offers a review of some of the work, since the Coleman report, which relates to the present study.

The Economics of Education Literature Since
the Coleman Report

A great many studies have appeared since the Coleman report; this review does not attempt to cover many of them in detail. Much of the literature can be described in terms of a few general approaches to the subject, though. A few articles of direct relevance to the present study will be treated in more detail.

As suggested already, the major trend in the literature has been an attempt to confirm or deny the Coleman results. Several papers appeared after the Coleman report criticizing its data and statistical techniques. Among the more prominent examples are articles by Hanushek and Kain, Bowles and Levin, and Cain and Watts.⁵ Hanushek and Kain, for example, point out serious sampling and nonresponse problems in the original data. They are also bothered by the Coleman report's concentration on the twelfth grade, where the unmeasured effects of tracking, self-selection (due to dropouts), and past schooling are so very important. Finally, they object to the stepwise analysis of variance technique that was used to separate the effects of background and school inputs. Entering the background variables first and the school variables second ensured the smallest possible school effects consistent with the data. If school inputs had been entered first,

⁵Eric A. Hanushek and John F. Kain, "On the Value of Equality of Educational Opportunity as a Guide to Public Policy," On Equality of Educational Opportunity, ed. by Frederick Mosteller and Daniel P. Moynihan (New York: Random House, Inc., 1972), pp. 116-145; Samuel Bowles and Henry Levin, "The Determinants of Scholastic Achievement: An Appraisal of Some Recent Evidence," Journal of Human Resources, 3 (Winter, 1968), pp. 3-24; Glen G. Cain and Harold G. Watts, "Problems in Making Policy Inferences from the Coleman Report," American Sociological Review, 35 (April, 1970), pp. 228-242.

they might have explained much more of the variance than they did, being entered last.

Because of problems such as these, a great many new studies have followed. On Equality of Educational Opportunity, edited by Frederick Mosteller and Daniel P. Moynihan, contains several reanalyses using the same data.⁶ Do Teachers Make a Difference? contains additional studies, some using the same data, and some using data from different sources.⁷ In addition, this volume contains a survey of much of the literature on school effectiveness.⁸ And Harvey A. Averch et al. review still more studies, all but a few from the years immediately following the Coleman report.⁹ Most of these studies have used regression analysis instead of analysis of variance. Ordinarily, the dependent variables have been measures of cognitive achievement. The independent variables have included a wide variety of school input and background measures. Generally, some school inputs have showed small, significant effects; studies have differed, though, on which ones. And invariably, the effects of socioeconomic status and/or race have been very much larger than any school input effects. Thus, while differing in many details, these studies have largely supported the

⁶Mosteller and Moynihan, op. cit.

⁷Do Teachers Make a Difference? (Washington, D.C.: U.S. Government Printing Office, 1970).

⁸James W. Guthrie, "A Survey of School Effectiveness Studies," in Do Teachers Make a Difference? (Washington, D.C.: U.S. Government Printing Office, 1970), pp. 25-54.

⁹Harvey A. Averch, Stephan J. Carroll, Theodore S. Donaldson, Herbert J. Kiesling, and John Pincus, How Effective is Schooling? A Critical Review and Synthesis of Research Findings (Santa Monica: The Rand Corporation, 1972).

Coleman report findings that background effects dominate, and that the marginal products of school inputs are very nearly zero.

With all of this support for Coleman's findings, one possible conclusion is that we are overspending on education. Moynihan has taken this approach in an article in Public Interest.¹⁰ He argues that an educational establishment exists that tends to promote its own interests by claiming to represent the public interest. The zero marginal product of schools indicates the success of educators in getting the public to spend on schools, far beyond the ability of these educators to use the money productively.

Others, though, would not accept this view. According to a second line of reasoning, Coleman, and most of those who have followed up his study miss the point of public education when they measure its output in terms of cognitive achievement. Education is primarily a socializing process--a process for the formation of attitudes. Gintis attempts to prove that affective characteristics are more important than cognitive ones in the economic value of education.¹¹ He also provides some evidence that these attitudes are, in fact, encouraged in schools. Brown suggests that such an emphasis of schools may explain their zero marginal product with respect to cognitive achievement.¹²

¹⁰Daniel P. Moynihan, "Equalizing Education: In Whose Benefit?" Public Interest, 29 (Fall, 1972), pp. 69-89.

¹¹Herbert Gintis, "Education, Technology, and the Characteristics of Worker Productivity," American Economic Review, 61 (May, 1971), pp. 266-279.

¹²Byron W. Brown, "Achievement, Costs, and the Demand for Public Education," Western Economic Journal, 10 (June, 1972), pp. 198-219.

While most studies have assumed cognitive achievement to be the output, and proceeded from there, Brown has turned the process around, testing whether evidence supports the contention that schools are trying to produce cognitive achievement. He develops a model which views education as one of a number of goods in a community's welfare function. Maximizing welfare subject to production functions and resource constraints requires that inputs be positively related to outputs in production functions, and that outputs be positively related to expenditures in cost functions. Both production and cost function estimates for cognitive achievement show relationships inconsistent with these requirements. Thus, the evidence does not support the contention that cognitive achievement is the output sought by schools.

These studies constitute a strong case against the a priori assumption that cognitive achievement is an adequate representation of the outputs sought by schools. They suggest the importance of further research into the question of what schools are trying to produce, before accepting an argument such as that put forth by Moynihan. In addition, Brown's study provides the procedure for this research, testing a priori hypotheses concerning outputs through the use of production and cost relationships. In its model as well as its general approach, the present study depends heavily on this study by Brown.

With the rejection of cognitive achievement as their sole output, one is forced to take a more complex view of schools; certainly no other single measure can adequately represent their output either. Levin and Michelson, in related articles, have made perhaps the most significant attempts so far to capture the multiple output nature of

schools.¹³ Michelson points out that results such as Brown's, that production and cost relationships do not show positive effects of inputs and expenditures, are consistent with the omission of other relevant outputs. That is, cognitive achievement need not be rejected as one output; it need only be rejected as the sole output. Levin sets out a multiple output model in some detail. In addition to a measure of verbal achievement, he treats measures of "student's attitude," "grade aspiration" and parents' attitude" as other school output measures. In his most general formulation, he considers each measure as the dependent variable in a production function including vectors of individual and family inputs, school inputs, peer or fellow student characteristics, other external influences, initial or innate endowment, and the other three outputs. Attitudes such as these have been used as explanatory variables in other studies. They have been treated as exogenous, though, a practice which Levin argues is invalid. Certainly these attitudes are jointly determined with cognitive achievement. In actually testing the model, Levin simplifies the interactions somewhat, but uses two stage least squares instruments for all outputs remaining as explanatory variables. His results suggest that some background factors work on verbal achievement indirectly, by affecting attitudes, rather than directly, as single output models have implied. He considers this result, though, to be only tentative.

¹³Henry M. Levin, "A New Model of School Effectiveness," and Stephan Michelson, "The Association of Teacher Resources with Children's Characteristics," both in Do Teachers Make a Difference? (Washington D.C.: U.S. Government Printing Office, 1970), pp. 55-78 and 120-168, respectively.

Levin and Michelson seem interested primarily in such technical interactions among outputs. Such interactions can be obscured if different districts are choosing to emphasize different outputs. To minimize differences due to choice, they use individual student data from a single district. Even so, as soon as there are several outputs, choice among outputs becomes an inevitable part of the educational process, and of its interpretation. Michelson makes this point especially clear:

It is too facile--and too common--to investigate one area of school production, ignoring the consequences in other areas. It could certainly be that a technique, say tracking, did successfully increase cognitive skill acquisition at all levels, and yet was entirely unacceptable as a method of school organization.¹⁴

Actually, such a technique would be acceptable to some people, but unacceptable to others, depending on the values they assign to cognitive and noncognitive outputs of schools.

The present study owes a good deal to these studies by Levin and Michelson. The treatment of multiple outputs is essentially the same. The importance of choice--of value judgments--is recognized. Indeed, even more than the studies of Levin and Michelson, this study makes choice the central issue. While Levin and Michelson try to minimize its effect on their data by using individual student data from a single district, this study uses data that are district averages. It predicts which district types choose to emphasize which outputs, and tests the hypothesis that such choice actually accounts for the explanatory power of community type variables, usually interpreted as indicating production function differences.

¹⁴Michelson, op. cit., p. 121

CHAPTER II

THE THEORY

Introduction

A community has many, varied goals for its children. Among these, ordinarily, would be the mastery of skills that the children will find necessary later in life. Also included would be the formation of "positive" attitudes--attitudes which reflect and support the community's values. The important skills ordinarily include both academic and social subjects. Important attitudes include children's feelings toward themselves, toward others and toward the institutions of society. The community as a whole tends to promote these goals for its own collective good. Since the community at large benefits from a more skilled population, with great ability and motivation, the community promotes these attributes. Since it has a vested interest in the existing institutions, it seeks to perpetuate them. Families, furthermore, are interested in the welfare of particular children. Families promote skills and attitudes in their children for the children's sake.

An important aspect of these goals is that, to a significant degree, they come from within the community. True, sometimes standards are imposed from outside. But with local communities usually left to implement them, the standards can ordinarily be bent to the community's own wishes. A community of "blue collar" families will probably

promote different skills and attitudes from a community of "white collar" families. These differences reflect, at least in part, the fact that families in the two communities have different ideas of what contributes to the welfare of their communities and their children. Differences exist within communities as well, and have the effect of turning explicit goals into fuzzy compromises. Differences among communities are more important, though, since they may lead to differences in goals, and, thus, make comparisons among districts a good deal more difficult. Any model of the system by which communities educate their children should allow for these possible differences.

Generalized Model

So far, schools have not even been mentioned explicitly. But clearly, schools are the institutions with the primary responsibility for promoting the community's goals with respect to children. The promotion of these goals is "education"--a process with as many facets as there are goals. This responsibility is their raison d'etre. Their prototype is the consumer cooperative. The community forms a district which chooses a board to run the schools for the benefit of that community. Thus, a variation on Brown's welfare function is an appropriate starting point:¹

$$W = W(E_1, E_2, \dots, E_m, G). \quad (2.1)$$

¹Brown, op. cit. Not just the welfare function, but the whole generalized model is heavily dependent on Brown's single output model. The form of the production function draws, as well, on Levin, op. cit.

W is the community welfare in a particular time period, E_i is the amount of education of type "i" (for example, "cognitive skill") consumed during that period, and G represents all other goods and services consumed in the period. The constraints are the production functions (2.2) and the available resources (2.3):

$$\begin{aligned}
 E_1 &= E_1(E_2, E_3, \dots, E_m, T_1, S_1) \\
 E_2 &= E_2(E_1, E_3, \dots, E_m, T_2, S_2) \\
 &\vdots \\
 &\vdots \\
 &\vdots \\
 E_m &= E_m(E_1, E_2, \dots, E_{m-1}, T_m, S_m)
 \end{aligned} \tag{2.2}$$

$$X + V = p_G G + \sum p_i T_i. \tag{2.3}$$

Each educational output is dependent on the others, as well as on a vector of purchased inputs (T_i) and a vector of other factors (S_i) affecting the education processes. The T_i and S_i vectors need not be the same for each output. That is, an important input to one aspect of education may have little or no relevance to some other aspect. Indeed, an input could have a positive effect on one output and a negative effect on some other. X represents the income derived internally from the community's wealth and V represents school aid to the district, mainly from the state government, but also, to some extent, from the federal government. X is exogenous, and since V is usually determined by formula according to community wealth and

district size (which are exogenous), V is exogenous too. Prices of inputs (p_i) and other goods (p_G) can be treated as fixed as well.² School boards, then, select their inputs so as to maximize (2.1) subject to constraints (2.2) and (2.3). This gives the efficiency conditions:³

$$\frac{MP_{ik}}{P_i} = \frac{MP_{jk}}{P_j} \quad \text{and} \quad \frac{\partial W}{\partial E_k} - \frac{MP_{ik}}{P_i} = \frac{\partial W}{\partial G} \Big/ P_G \quad (2.4)$$

MP_{ik} is the marginal product of the i th input with respect to the k th output, $\partial W / \partial E_k$ is the marginal effect on welfare of the k th educational output and $\partial W / \partial G$ is the marginal effect on welfare of the other goods and services. A cost function can be derived from the production functions and the cost constraint: $C = \sum p_i T_i$. Minimizing C subject to (2.2), and solving for total cost, one gets:

$$C = C(E_1, E_2, \dots, E_m, S_1, S_2, \dots, S_m, p_1, p_2, \dots, p_n). \quad (2.5)$$

The cost function gives the marginal costs of each of the outputs, along with their inverses, the marginal product of a dollar spent on each. Furthermore, one can derive the trade-offs among the various

²The model must be limited at some point. Clearly, the prices would be endogenous in a larger model, including supply and demand functions for the inputs and other goods. Even community resources might be considered endogenous, since people will make decisions to move into or out of a district in part on the basis of its schools. These complications seem of marginal significance to this study, though, and have been excluded.

³While it may be theoretically possible for these conditions to be inconsistent, the possibility has not been pursued in this case.

outputs available to the districts. The function gives the combinations of outputs that are possible, given a particular expenditure level.

This general formulation of the production-cost relationships has skirted the problem of aggregation. Education takes place in individuals. Each child has his own parents, his own native abilities, his own past history. Thus, even with the same school inputs applied to each child, the results will ordinarily vary. The output of the school ought really be described by the whole distribution of individual outcomes. Now it may be that the shape of the distribution will be more or less fixed. This might be true, for example, if institutionalized classroom arrangements ensure that, in practice, each child gets very much the same inputs as do his peers. But this result need not obtain. Schools may be able to affect the shape of the distribution by the way they allocate inputs among children. That is, giving each child the same combination of inputs is only one possibility. Others might include spending the same dollar amount on each child, spending the most on those with the greatest "potential," or attending most to those with the greatest "need." Even if districts can affect the distribution of individual outcomes by such shifts in inputs, though, the question remains of whether districts treat such distributional considerations as being equal in importance to those of aggregate level. That is, might they sacrifice aggregate output in order to affect the shape of its distribution? Since the data are not available for inputs, outputs and expenditures on an individual student level, however, an assumption will be necessary. This study will assume that affecting the shape of the distribution is not a separate goal,

warranting a trade-off with its aggregate level, and that mean outcomes are not sensitive to such differences in outcome distributions as may exist. Such an assumption allows the use of district means to represent the whole district output in comparisons among districts.⁴

The Inputs

The purchased inputs are the tools that a school board uses as policy variables. The board balances the number of teachers against the amount of equipment, one set of teacher attributes against another, one machine or textbook against another. Since teachers probably have positive effects on both cognitive and noncognitive skills, one would expect teachers per pupil (the inverse of class size) to show significant positive relationships to these outputs. Nonteaching professionals per pupil, representing the availability of guidance, health and special education personnel, should have similar positive effects, though the outputs they affect most strongly may be different. The effects of administrators and supervisors, also included in this category, should be positive too. The popular idea that such people are nonproductive, or even negatively so, arises from the assumption that one more administrator means one less teacher. Unfortunately, most of the research in the education literature has been equally lax in controlling for other factors, to the extent that Vincent considers

⁴Brown and Saks, in a forthcoming paper, show evidence that schools do affect the standard deviation of cognitive achievement, as well as its mean level. It is not clear, though, that their results imply a tradeoff between the two. Byron W. Brown and Daniel H. Saks, "The Production and Distribution of Cognitive Skills Within Schools," Journal of Political Economy, forthcoming.

the effects of more teachers or nonteaching professionals per pupil to be still unresolved.⁵ As he points out, though, the theoretical case for the importance of class size is somewhat weaker than intuition might suggest. Smaller classes allow more use of teacher-student interaction techniques which research has showed effective in raising cognitive skills.⁶ But the teacher who lectures to twenty students as he would have to forty students may not be any more effective in the smaller class. Decreasing class size will be effective only to the extent that it opens up opportunities to teachers, and that teachers actually take advantage of these opportunities.

The demand for the teacher input provides a good example of the Lancaster theory of demand, that what is being demanded is a package of attributes.⁷ Of course, the attributes that actually make a teacher good are difficult for a school board to measure. The board ordinarily uses proxies such as experience, the level of education achieved and verbal ability as indicated by standardized tests. Research has showed verbal ability to be one of the most important attributes in producing cognitive skills.⁸ Such a result is hardly surprising since language

⁵William S. Vincent, "Class Size," Encyclopedia of Educational Research (Toronto: The Macmillan Co., 1969), pp. 141-146.

⁶Ned A. Flanders and Anita Simon, "Teacher Effectiveness," Encyclopedia of Educational Research (Toronto: The Macmillan Co., 1969), pp. 1423-1434.

⁷Kelvin J. Lancaster, "A New Approach to Consumer Theory," Journal of Political Economy, 74 (April, 1966), pp. 132-157.

⁸Guthrie, op. cit.; Erik Hanushek, Education and Race An Analysis of the Educational Production Process (Lexington, Mass.: D.C. Heath and Co., 1972).

skills constitute the major portion of cognitive skills, and since so much of what is taught, even of nonlanguage skills, is communicated verbally. Teaching experience also seems to contribute to the production of cognitive skills,⁹ suggesting that teachers learn, through trial and error, what techniques work for them.

Additional education of teachers, at least as represented by masters degrees, seems not to contribute to cognitive skills.¹⁰ This result could reflect an emphasis of teacher education programs on noncognitive goals instead. Apparently, though, such a hypothesis has never been tested. The work relating a few inputs specifically to cognitive scores is relatively new, and as much the product of economists and sociologists as traditional educators. It is a striking failure of the general education literature, on the other hand, that it has tended to treat inputs and outputs as unrelated topics. Writers analyze the "effectiveness" of inputs without defining "effectiveness" in terms of outputs. Thus, Stiles and Parker can review a literature on the "Evaluation of Teacher Education Programs"¹¹ without ever suggesting that the important benefits of teacher training are those which accrue to the trainee's future pupils, and that an appropriate test of teacher education programs might involve defining and testing for the intended benefits to these pupils.

⁹Ibid.

¹⁰Erik Hanushek, op. cit.

¹¹Lindley J. Stiles and Robert P. Parker, Jr., "Teacher Education Programs," Encyclopedia of Educational Research (Toronto: The Macmillan Co., 1969), pp. 1414-1423.

Any purchased input must have an "overall" positive relationship to the outputs. Some inputs, though, may be specific to certain outputs, having little effect on the rest. Economic theory even allows some inputs to have negative effects on some outputs, borne for their positive effects on others. It is these special relationships that one would like to predict a priori through the education literature. But as indicated, this literature offers no real help. Certainly it offers no basis for predicting any negative relationships. In the absence of significant prior evidence to the contrary, the hypothesis, adopted for purposes of subsequent production function estimates, will be that the purchased inputs have positive effects on all the outputs.

Identifying purchased inputs is ordinarily not a problem. Schools must pay for a wide variety of physical inputs as well as paying wages to teachers and other personnel. An ambiguity arises, though, especially with respect to personnel, who bring with them many attributes. Some of these attributes may be valuable to districts and worth paying extra to get. Others are worth no extra--they just happen to come with the individuals. By regressing the attributes of teachers on salaries paid, one can ascertain the qualities that are being bought. It is these that should contribute to the outputs. Those that are not being bought should not. For example, if masters degrees are being bought, in the sense that a teacher with one gets paid more, other things equal, then the hypothesis is that masters degrees are positively related to outputs. Otherwise, the hypothesis is that they are not. Further, the hypothesis will be that both experience and additional education are, in fact, purchased.

Regressing the attributes of teachers on salaries paid can also shed some light on the correlate issue of whether sex discrimination exists in the pay of teachers. Levin's study showed about a \$400, or 5.6% difference in favor of males, other things equal.¹² This result will be checked by including the teacher's sex among the teacher qualities regressed on salary. The hypothesis is that such a differential does exist in favor of males. Levin did not address the matter of differences in productivity. At least to some, a clear difference in productivities would be justification for some difference in pay. Yet there seems little consensus in the literature that such a difference exists. If it does, the easier argument may be that women, by nature or cultural conditioning, are more adept at dealing with young children. The counterargument, advanced by Patricia Cayo Sexton, is that there are presently not enough male teachers to provide role models for boys, and that this fact accounts for the lower success of boys in school.¹³ The implication is that the marginal products of men are higher, if only because of their scarcity in the lower grades. In the absence of corroboration, though, neither argument seems terribly convincing, and the hypothesis must be that the sex of the teacher makes no difference in the production of education. If this hypothesis is supported, then any difference in salaries, purely on the basis of sex, is clearly discriminatory.

¹²Henry M. Levin, "A Cost-Effectiveness Analysis of Teacher Selection," *Journal of Human Resources*, 5 (Winter, 1970), p. 30. The percentage is based on mean salary.

¹³Patricia Cayo Sexton, The Feminized Male: Classrooms, White Collars and the Decline of Manliness (New York: Random House, 1969).

The Background Factors

The "other factors" lumped in the vector "S" may constitute the most powerful influences of all on outputs. These factors include individual student characteristics such as native ability and previous education. The first is involved, virtually, by definition, though, in practice, its measurement has proved elusive. As for the latter, ordinarily, the students will do best in the third grade who were best prepared for it through the second grade.

Other "environmental" characteristics are important too. They can be divided into family, peer (classmate) and community influences. Each of these groups can support particular educational experiences. For example, a parent who is seen by his children making regular use of basic cognitive skills is probably supporting his children's own cognitive performance, as well as their attitudes toward the importance of these skills. A parent who seldom reads or writes might have the opposite effects. Beyond the family, a student's classmates and community at large can provide further such influences, positive or negative.

These background influences are important, but not as policy variables. In fact, a school board can do little to affect the background influences in its district. The board, though, is affected by the community which elects it. Indeed, one would expect that this ability to influence the board in its goals accounts for some of the powerful background effect, at least if Myrdal's pragmatic social conception of American education is to be operationally meaningful.¹⁴

¹⁴Myrdal, op. cit.

Past models of education, assuming at the start only one output, have been forced to ignore this important possibility. Once one assumes a single output that all districts are pursuing, then he must conclude that differences in the achievement of that output, school inputs equal, are due to differences in the ability of communities to produce. With a number of outputs possible, though, differences in particular outputs may largely represent differences in priorities.

The point can be illustrated with the simple graph of Figure 1.¹⁵ Lines I and II represent constant expenditure product transformation curves for outputs X and Y. That is, I represents all efficient combinations of the two outputs that can be produced at a given expenditure level. II represents the same, but at a higher expenditure level. Constant expenditures are used, rather than constant inputs, since it would be only rational for districts choosing different outputs to choose different inputs accordingly. The relevant constraint on a district's choice among outputs is not simply the technical one, of what choices exist given a fixed bundle of inputs, but the more general economic one, of what choices exist given the optimal use of its resources. Now suppose one were to make the mistake of relating expenditures only to output X. He would conclude that school district B is producing less than school district A, despite an equal expenditure--that, indeed, school district D is producing less than A, despite an even higher expenditure level. If B and D are both lower class districts, he might "explain" their "poor" showing by concluding that,

¹⁵Adapted from Michelson, op. cit., pp. 123-125.

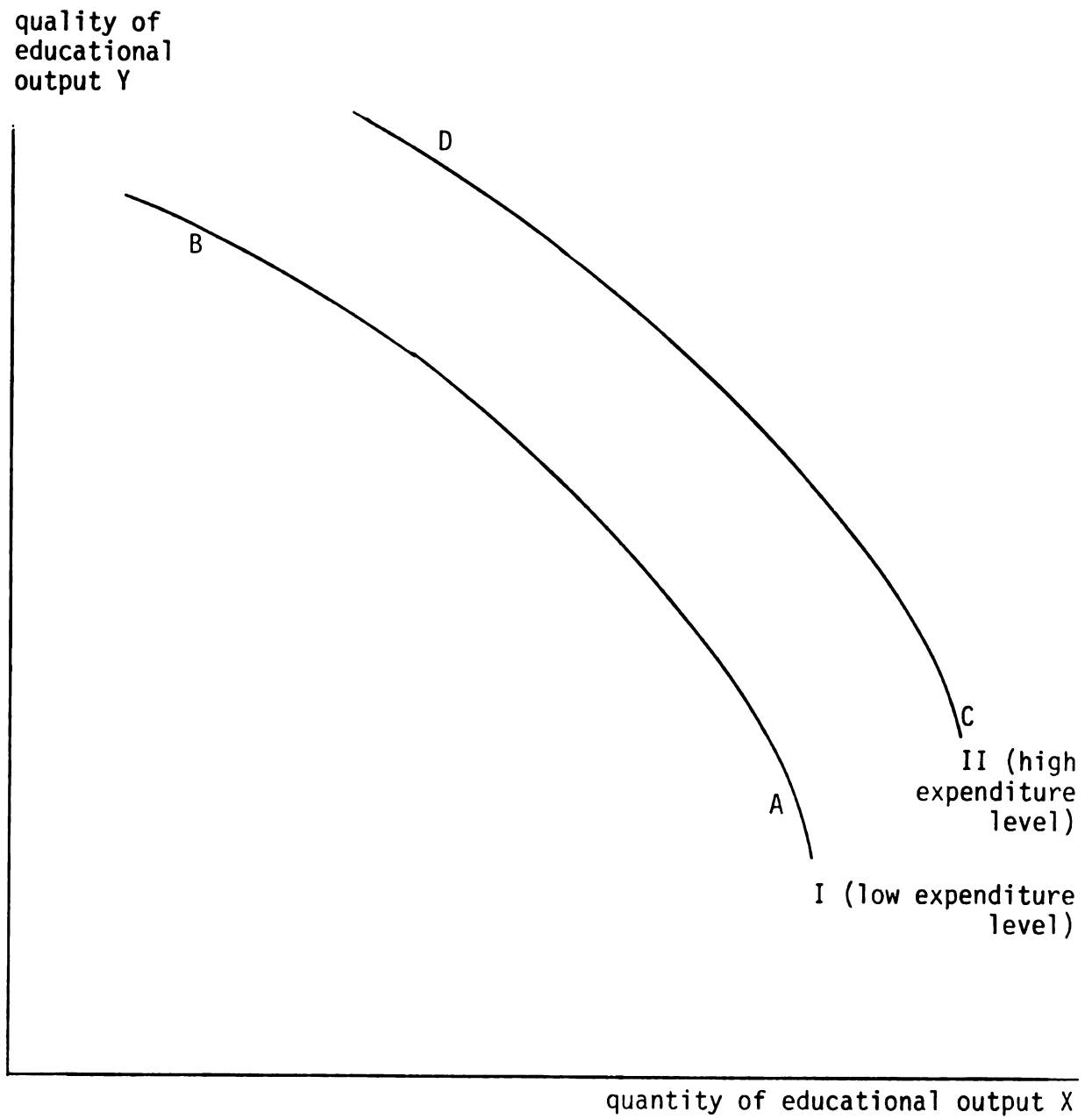


Figure 1.--Constant Expenditure Product Transformation Curve for Educational Outputs X and Y.

other things equal, lower class schools do not do as well. But clearly, this explanation would be wrong. These districts could have produced at points A and C respectively. They chose to produce less of output X in order to produce more of output Y. As long as districts face the same product transformation curves, their ability to produce is the same. Lower class schools actually do less well only if their whole product transformation curve is inside that faced by the higher class schools. That is, if I and II represented the possibilities open to low and high class schools at the same cost, then the lower class schools would, in fact, be inferior. The major hypothesis to be tested, though, is that background factors, such as socioeconomic status and race, do not affect the constant expenditure product transformation curve itself, but only the choice of points along this curve. If the usual strong background effects evidenced for single outputs become insignificant with the inclusion of the other outputs, the hypothesis will be supported; otherwise it will not.

The Outputs

Potential outputs must be chosen a priori. Simple correlation with inputs or costs does not guarantee something to be an output sought by schools. Some things may be related only coincidentally, others causally but unintentionally, some, presumably, by conscious choice. The a priori model is the only means for discrimination. One must look, first, to the education and sociology literature to find what it is that schools are supposed to do.

The literature on the goals and outcomes of education is extensive. Ammons,¹⁶ in her review article, gives a lengthy bibliography on the subject. Moreover, state boards of education have increasingly taken it upon themselves to set down their goals. Pennsylvania, for example, hopes to:

- (1) help every child acquire the greatest possible understanding of himself and an appreciation of his worthiness as a member of society,
- (2) help every child acquire understanding and appreciation of persons belonging to social, cultural, and ethnic groups different from his own,
- (3) help every child acquire to the fullest extent possible for him mastery of the basic skills in the use of words and numbers,
- (4) help every child acquire a positive attitude toward school and toward the learning process,
- (5) help every child acquire the habits and attitudes associated with responsible citizenship,
- (6) help every child acquire good health habits and an understanding of the conditions necessary for the maintenance of physical and emotional well-being,
- (7) give every child opportunity and encouragement to be creative in one or more fields of endeavor,
- (8) help every child understand the opportunities open to him for preparing himself for a productive life and enable him to take full advantage of these opportunities,
- (9) help every child to understand and appreciate as much as he can of human achievement in the natural sciences, the social sciences, the humanities, and the arts,
- (10) help every child to prepare for a world of rapid change and unforeseeable demands in which continuing education throughout his adult life should be a normal expectation.¹⁷

Such goals illustrate well Myrdal's concept of American education, described in the introduction,¹⁸ By itself, though, the list

¹⁶Margaret Ammons, "Objectives and Outcomes," Encyclopedia of Educational Research (Toronto: The Macmillan Co., 1969), pp. 908-914.

¹⁷Paul B. Campbell, et al., Phase One Findings: Educational Quality Assessment (Harrisburg: Pennsylvania Department of Public Instruction, 1968), as cited in Purposes and Procedures of the Michigan Assessment of Education: Assessment Report Number One (Lansing: Michigan Department of Education, 1969), pp. 7-9.

¹⁸Myrdal, op. cit.

offers no guidance with respect to the kind of backgrounds most likely to promote various of these goals. Perhaps the most systematic study of the goal preferences of various background types is that reported by Downey in The Task of Public Education: The Perceptions of People.¹⁹ For their study, the researchers constructed their own list of goals, and asked a carefully chosen sample of nearly four thousand respondents to rank them. The choices for elementary schools were as follows; each was printed on a separate card, without the numbers or category names included here in brackets.

[Intellectual]

- [1] A fund of information about many things.
- [2] The basic tools for acquiring and communicating knowledge--the 3 R's.
- [3] The habit of figuring things out for one's self.
- [4] A desire to learn more--the inquiring mind.

[Social]

- [5] The ability to live and work with others.
- [6] Understanding rights and duties of citizenship and acceptance of reasonable regulations.
- [7] Loyalty to America and the American way of life.
- [8] Knowledge of and appreciation for the peoples of other lands.

[Personal]

- [9] A well cared for, well developed body.
- [10] An emotionally stable person, able to cope with new situations.
- [11] A sense of right and wrong--a moral standard of behavior.
- [12] Enjoyment of cultural activities--the finer things of life.

[Productive]

- [13] General awareness of occupational opportunities and how people prepare for them.
- [14] Classification and training for a specific kind of high school program--academic, technical, etc.
- [15] Understanding the role of various family members.
- [16] An introduction to budgeting and effective use of money and property.²⁰

¹⁹ Lawrence W. Downey, The Task of Public Education: The Perceptions of People (University of Chicago, 1960).

²⁰ Ibid., p. 87.

The respondents ranked "the 3 R's" first, followed by goals 4, 5, 3, 11, 6, 7 and 10, in that order.²¹ There were differences, though, in the degree of emphasis on particular goals, which related significantly to background characteristics of the respondents. While income did not seem to contribute to these differences, both occupational status and education did. Quoting from the report:

The higher one's position on the occupational continuum, the greater the importance he assigned to the intellectual, the aesthetic, and world citizenship aspects of the task; conversely, the less importance he assigned to the physical, the moral, the consumer, and the vocational aspects. Similarly, the more schooling respondents had themselves, the more they tended to emphasize the intellectual aspects and minimize the social, physical, and vocational aspects of education.²²

Among other significant background differences, the report also found that "Negroes, as a group, placed greater emphasis upon the physical, the social, and the moral than did whites."²³

On the assumption that schools tend to reflect the characteristics of the communities that they serve, Downey's results provide a straightforward basis for hypotheses on the actual emphasis of different schools. Bidwell suggests that the "decentralization [of American education] makes schools especially vulnerable to local sources of political pressure,"²⁴ a conclusion which supports the use of local preferences to predict actual school behavior. Others,

²¹Ibid., p. 36. For non-educators--for educators, 7 and 10 were reversed.

²²Ibid., p. 65.

²³Ibid.

²⁴Charles Bidwell, "Sociology of Education," Encyclopedia of Educational Research (Toronto: The Macmillan Co., 1969), p. 1246.

though, view education, and the sources of local variation, in a much more deterministic light. Such a view rejects significant local autonomy, regarding America as a national social and economic unit. Its structure is essentially "bureaucratic." Such a structure, common to developed countries, differs from the "traditional" in placing less emphasis on the maintenance of an elite, and more on sorting by "ability" for placement within the bureaucracy.²⁵ Ability, in this context, often has been discussed as if intellectual ability were intended, but the personality attributes that enable one to mesh well with the bureaucratic structure may be more important. Gintis, referring to work by Merton and Weber, identifies "subordinancy," "discipline," "supremacy of cognitive over affective modes of response" and "motivation according to external reward," as important attributes.²⁶ These, he suggests, may be more important than cognitive skill in providing the basis for an economic return to education because of the highly bureaucratized nature of capitalistic production. He argues that schools promote these attributes by systematically rewarding students for them, and by penalizing students for "creativity," "autonomy," "initiative," "tolerance for ambiguity" and "independence."²⁷

Two general comments are relevant. First, in a very broad sense, Gintis concurs with educators and the public that noncognitive goals represent an important aspect of education. The goals, themselves, certainly sound much more wholesome as described by educators

²⁵ Ibid., p. 1243.

²⁶ Gintis, op. cit., pp. 266-279.

²⁷ Ibid.

and the public than as described by Gintis. Much of the difference, though, must be ascribed to the perspectives of the commentators. Most educators certainly identify with the bureaucratic social and economic system; so, too, do most members of the public--even most of those in its lower strata. To them, the social structure is given. A "good" education is one that prepares children for this society, within which their success will be measured. Gintis, on the other hand, clearly takes on the role of social critic. From this perspective, the successful socialization, which to the others is an attribute of "good" education, takes on a much more sinister cast. The difference in perspective is essentially a normative matter. Whether "help[ing] every child understand the opportunities open to him . . ."²⁸ is interpreted a la Myrdal or Gintis is somewhat a matter of taste. But many sociologists would reject Gintis' assertion "that the economic productivity of schooling is due primarily to the inculcation of personality characteristics which may be generally agreed to be inhibiting of personal development."²⁹ Such an assertion implies the possibility of a social structure more conducive to "personal development." To Gintis, this structure is socialism.³⁰ But Weber's other structures--traditional and charismatic--would not answer Gintis' objections. They would certainly not guarantee less

²⁸Campbell, et al., op. cit.

²⁹Gintis, op. cit., p. 267.

³⁰For elaboration of this viewpoint, see: Herbert Gintis, "Alienation in Capitalist Society," The Capitalist System; A Radical Analysis of American Society, ed. by Richard C. Edwards, et al. (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1972), pp. 274-285.

"subordinancy," for example. And Weber, himself, considered socialism to be simply a different bureaucracy.³¹ At best, the sociological literature gives little hint of the general agreement which Gintis suggests.

The second general comment is that, unfortunately, this literature has remained quite macroscopic, offering little basis for predicting differences in educational goals within society. Gintis acknowledges this limitation, observing in a footnote:

In this paper we shall treat only those required traits which are common to all levels in the hierarchy of production, and are inculcated in most schools on all levels. Actually the personality requisites of job adequacy no doubt vary from level to level within the hierarchy of production, and different levels of schooling (e.g., grade school, high school, junior college, college) likely reflect these differential needs. Moreover, within a particular educational level, we would expect different types of schooling to subsist side by side (e.g., ghetto, working-class, and middle-class-suburban high schools) reflecting the differential positions in the production hierarchy that its students are destined to fill. These complications, however important, cannot be treated here.³²

Speculating, though, on what such a sociological view would predict about the outputs emphasized in different communities,³³ the results might not be very different from the desires expressed by the public. The causation, of course, would be different. The need to perpetuate the bureaucracy, not individual choice, would determine any differences in goals. But those at the top of the bureaucratic structure are the

³¹Talcott Parsons, The Structure of Social Action (New York: McGraw-Hill, 1949), pp. 506-513.

³²Herbert Gintis, "Education, Technology, and the Characteristics of Worker Productivity," American Economic Review, 61 (May, 1971), p. 272.

³³The following should not be attributed to Gintis or any of the others cited, but represents the author's speculation as to where their theories might lead with respect to differences in goals within society.

ones responsible for policy decisions. Presumably, those "destined" for such positions would need perspective and intellectual ability. Those who will fill lower positions would need progressively narrower intellectual skills, and, perhaps, greater willingness to accept the status quo. The concurrence of the public in these differences in educational goals would simply indicate the success of the socialization of the previous generation.

It may be important, for policy questions, whether the public is expressing free choice, or acting in a predetermined manner. For purposes of predicting the outputs of various schools, though, the results seem to be similar in the two cases. Thus, the general results, quoted from Downey, above, will be the basis for hypotheses as to the emphasis of schools serving different community types. It is worth noting that such hypotheses add credence to the argument advanced in Figure 1, above, that past results are biased. Output X, used in past studies, is cognitive achievement, which Downey found a more important goal among those of higher socioeconomic status, who would inhabit communities like A and C. Hence, the improper inference that the higher socioeconomic status schools were better.

Specifically, the hypothesis is for a positive relationship between "intellectual" outputs and community background factors of socioeconomic status and per cent white in production and cost functions which improperly include only these outputs. Of course, this is nothing more than the widely accepted result of past studies, usually interpreted to indicate greater ability to produce on the part of these districts. However, the result is also consistent with the major

hypothesis that background effects work through choice, since high socioeconomic status and white communities do choose these outputs more. This major hypothesis, though, implies that these same districts should be producing less of other outputs. That is, the hypothesis is for a negative relationship between "personal," "social" and "productive" outputs and these same background factors in production and cost functions which improperly include only these outputs. Such a result, added to the previous one, would, at least, refute single output models based on the assumption that the other outputs relate to "intellectual" ones in approximately fixed proportions. Higher socioeconomic status and per cent white would no longer simply imply "more." Whether working through choice or ability to produce, higher socioeconomic status and per cent white would imply more of some outputs and less of others. The major hypothesis, of course, is that these effects work through choice. If so, production and cost functions would exhibit background effects only through misspecification; the background factors would show effects only because of the omission of the other relevant outputs. Thus, the hypothesis is for these same background effects to become insignificant in production and cost functions properly including all outputs. If not, the major hypothesis must be rejected; at least some of the background effects take place through production-possibilities.

One other set of relationships requires comment--the relationships among the various outputs themselves. The clear assumption of most previous work has been that they are joint products, produced in approximately fixed proportions. This assumption represents the only

justification for acknowledging others, besides cognitive achievement, and then ignoring them. This study, by positing a tradeoff, explicitly rejects that assumption. With fixed resources, at least some of the outputs must be substitutes. Apparently, the four goals Downey describes as "intellectual," plus the "aesthetic" and "world citizenship" goals are complements in consumption; the "intellectual" goals, at least, seem good candidates to be complements in production as well. The "basic tools" seem a requisite to "the habit of figuring things out for oneself," and both should support and be supported by the "desire to learn more." The remaining "social" and "personal" goals, representing general socialization, are also probably complementary products, since, as already indicated, personal development presupposes a social context. At least the first two of the "productive" goals, representing vocational orientation, would certainly be complements in production, too. Within each of these groups, the promotion of one goal should tend to promote the others as well. Among such groups, though, a concentration on one leaves fewer resources for the others. Thus, with fixed resources, a district concentrating more on intellectual goals must sacrifice other types of goals. A district concentrating more on the other types of goals must sacrifice the intellectual ones.

Summary

1. Economic theory predicts that purchased inputs should have positive effects on outputs. In a complicated process involving multiple outputs, it is possible for some purchased inputs to have

negative effects on some outputs, borne for their positive effects on others. But in the absence of any indication of such relationships in the general education literature, the hypothesis will be adopted that all the purchased inputs have positive effects on all the outputs.

2. To determine which teacher attributes are, in fact, purchased, these attributes will be regressed on teacher salary. It is those positively related to salary which are being purchased, and which should show the positive relationship to output; others are not being purchased, and should not show such a relationship to output. The hypothesis will be that both experience and additional education are, in fact, purchased attributes.

3. The process outlined above allows a test of sex discrimination among teachers. If male teachers are paid more, and are not more productive, then discrimination clearly exists. Previous work suggests the hypothesis that a pay differential does exist in favor of males. In the face of conflicting theories, though, the hypothesis must be that the sex of the teacher makes no difference in the production of education.

4. The major hypotheses of this study are that schools choose to produce different outputs, consistent with, and probably as a result of community preferences, and that it is this choice, not differential ability, that leads to the large effects of background factors on individual outputs. In support of these general hypotheses, the specific predictions are for:

a. a positive relationship between "intellectual" outputs and community background factors of socioeconomic status and per cent

white in production and cost functions which improperly include only these outputs (as in past studies);

b. a negative relationship between "personal," "social" and "productive" outputs and these same background factors in production and cost functions which improperly include only these outputs (since choosing relatively more of the "intellectual" implies choosing relatively less of the others);

c. these same background effects to become insignificant in production and cost functions properly including all outputs;

d. the "intellectual" outputs and other outputs to be substitutes, each having a negative effect on the other in production and cost functions.

CHAPTER III

THE DATA

Introduction

The data to test the foregoing hypotheses will be that of the Michigan Educational Assessment Program. The Assessment data have been collected, in varying forms, over the last three years. They include district values for inputs, finances and various background characteristics, averaged across all grades. They also include district average values for tests given to fourth and seventh graders.¹ At the fourth grade level, school is apt to be the single most important influence on children outside of the family. Attitudes are more likely to be sought explicitly in the lower grades. And, since the confounding effects of such programs as tracking are less apt to be important, the use of district mean values for inputs, outputs and expenditures should be more representative of actual student experience. Thus, only fourth grade test data will be used. To further guarantee the homogeneity of the data, only these districts with full kindergarten through twelfth grade programs will be used. 519 district observations remain.

Of the three annual surveys available so far (1969-70, 1970-71, 1971-72), the third is, decidedly, the least complete. The questionnaire

¹The econometric problems with using averages will be considered in the next chapter.

relating to background factors and attitudes was not administered, apparently because of strong reactions against its personal nature. Thus, for the purposes of the present study, this third survey is unusable. The two earlier surveys both include measures of cognitive achievement and attitudes of students, along with inputs and expenditures of schools and background characteristics of communities. Each survey has its strengths and weaknesses. The first (1969-70) includes some input data, such as the percentage of male teachers, and financial data, such as federal aid, which were dropped from later surveys. On the other hand, the measures of achievement, attitudes and background factors were constructed from rather short questionnaires. The background and attitude measures were all derived from a total of only twenty-five questions. The second survey (1970-71) lengthened and improved both cognitive and noncognitive questionnaires. Because of the central importance of the measures derived from these questionnaires, and the marginal nature of the extra information in the first survey, the second survey will be used as the basic data for this study. However, in cases in which the second survey omits a variable entirely, the first survey will be used to augment the second. The following gives a brief description of the specific variables to be used; further information is available in technical reports of the Assessment program.²

²A whole series of reports has accompanied each of the surveys. Of most relevance are: Local District and School Report: Explanatory Materials The Third Report of the 1970-71 Michigan Educational Assessment Program (Lansing: Michigan Department of Education, June 1971); Educational Testing Service and Michigan Department of Education, Technical Report of Selected Aspects of the 1969-70 Michigan Educational Assessment Program (Lansing: Michigan Department of Education, August 1971);

The Inputs

The purchased inputs available are limited to personnel related attributes. These attributes include teacher-pupil ratio (TEACH/PUP) and the ratio of nonteaching professionals to pupils (NONTTEACH/PUP). The first is available from the 1970-71 data as the inverse of the pupil-teacher ratio. The pupil-staff ratio is available too, and NONTTEACH/PUP is the inverse of this minus TEACH/PUP. TEACH/PUP and NONTTEACH/PUP can be interpreted as measuring the amount of the services of teachers and others that are available to each student. To the extent that teachers teach whole classes at a time, the student gets much more like the total teaching time and TEACH/PUP may not be as important as it might at first seem. But a higher TEACH/PUP means, at least, that a teacher is more apt to be able to attend to individual student problems and to tailor his instruction, rather than to be forced to abandon his "problem" students. A higher NONTTEACH/PUP means, likewise, that more individual and specialized attention is available. Clearly, both are ordinarily considered positive inputs to the education process, and, clearly, to increase either requires additional expenditure (see pages 16-17, above).

Average teaching experience (AV EXPER) and the percentage of the faculty with masters' degrees (PCT MASTERS) measure the "quality" of the teacher inputs. Both measures are available in the 1970-71 data, though the AV EXPER figure is for the previous year. It can

Educational Testing Service, Technical Report The Ninth Report of the 1970-71 Michigan Educational Assessment Program (Lansing: Michigan Department of Education, June 1972).

be argued, of course, that they are only proxies for real quality--the ability of teachers actually to induce learning--but they are among the best measures available, even to the school board. In fact, schools ordinarily pay a premium for both. The schools Levin examined, for example, paid over \$75 per year of experience, almost \$400 per year of schooling, and over \$560 for a higher degree (about 1.1%, 5.6% and 8.0%, respectively).³ It would certainly be irrational for districts to act this way if these qualities were not associated with productivity (see pages 17-19, above).

The percentage of male teachers (PCT MALE) is also available in the 1969-70 data. This is not a quality attribute in the same sense as those above. There is no a priori reason to expect it to relate to productivity. While Levin found males to be paid about \$400 more than females (about 5.6%), other things equal,⁴ the hypothesis is that this discrepancy indicates discrimination rather than different productivities. Nevertheless, PCT MALE will be tested along with AV EXPER and PCT MASTERS, for evidence of the qualities for which the districts do pay more. Such qualities, then, along with TEACH/PUP and NONTEACH/pup, represent purchased inputs--inputs which districts value and pay to obtain. The expectation is that all but PCT MALE are positively related to output in the production process (see page 20, above).

These inputs all represent averages, from kindergarten through twelfth grade, while outputs are measured at the fourth grade. Production

³Levin, op. cit., p. 30. The percentage is based on mean salary.

⁴Ibid.

function estimates will be biased to the extent that these input averages do not represent the experience in the first four grades. Male teachers, for example, are probably much more common in the upper grades than in the first four. If so, a high PCT MALE might reflect a heavier emphasis on the upper grades, rather than a higher percentage of male teachers in the lower grades. PCT MALE would show a spurious negative effect on fourth grade output. To help prevent inputs from picking up this variation in emphasis on the relevant grades, the percentage of teachers at the elementary level (PCT ELEM) will be included in production function estimates to represent this emphasis explicitly. It should be positively related to fourth grade output.

The Financial Data

Clearly, a great many other inputs are purchased by districts, but, unfortunately, data on them is just not available. This fact places serious limitations on the interpretation of production function estimates. A lack of significant relationships between hypothesized outputs and available inputs may mean that the potential output is not being sought by schools--or only that the important inputs have been omitted. Fortunately, this ambiguity does not exist with cost functions. Total instructional expenditure per pupil (INSTR) is given in the 1970-71 data, again for the previous year. This must bear a positive relationship to outputs in the cost function, or the outputs are not what the schools are trying to achieve, at least at the margin.

Expenditures, of course, depend on resources available. The state equalized valuation per pupil (SEV) measures the value put on

property for tax purposes per pupil. The 1970-71 data include SEV which indicates a community's wealth, as well as state school aid per pupil (SSA), both for the previous year. In addition, the 1969-70 data indicates Elementary and Secondary Education Act funds per pupil (ESEA), and other federal aid per student (FED OTH).

Price information is necessary, too, since a certain dollar expenditure will go less far in a high price district. The only school price data is average salary (AV SAL) for the year before. But as Brown points out, AV SAL may reflect a quality of teachers chosen as well as the general price level in the district for all goods and services.⁵ By itself, it is probably not a good price index. But it should be possible to disentangle part of the variation in AV SAL due to teacher attributes. The regression:

$$\begin{aligned} \text{AV SAL}_i = a_0 + a_1 \text{AV EXPER}_i^* + a_2 \text{PCT MASTERS}_i^* \\ + a_3 \text{PCT MALE}_i^* + e_i \end{aligned} \quad (3.1)$$

where i represents the individual district, explains as much of the variation in AV SAL as possible with variations in teacher attributes. The stars indicate the use of variations from the mean. The remaining variation is assumed to be price level variation. The only reason for using variations from the mean is that the constant then reflects AV SAL with mean attributes rather than with zero attributes. Another variable, then, can be calculated for each district:

⁵Brown, op. cit.

$$\begin{aligned} \text{SAL}_i = \text{AV SAL}_i - [a_1 \text{AV EXPER}_i^* + a_2 \text{PCT MASTERS}_i^* \\ + a_3 \text{PCT MALE}_i^*]. \end{aligned} \quad (3.2)$$

SAL represents the salary level that, presumably, would have obtained if the district had hired the mean amounts of the teacher attributes. It will be used as the price level index for each district, in cost function estimates.

This method of representing price level requires the somewhat unrealistic assumption of equilibrium in labor markets. Otherwise, there will be some reversal of causation, from the general salary level to the measured attributes. That is, some districts may have abnormally high salary levels, which attract a surplus of teachers. These districts, then, will tend to choose the most qualified of those available, even if the qualifications were not the reason for having the high salary levels. Thus, this method may give values for $a_1 - a_3$ that are biased upward.

Since Levin has already estimated an equation similar to (3.1),⁶ his coefficients could be used instead of estimating new ones. His study, though, included five other attributes not available in the present data. Furthermore, since his estimates were within, not among districts, none of the salary variation he observed could be explained by price level variation. Thus, it is questionable that his results are relevant in the present context of finding a price level index.

⁶Levin, op. cit.

Finally, there is no compelling reason to expect market disequilibrium biases to be less important in his study.

An alternative, nonschool wage could be used as a price level indicator. But, any single alternative wage figure, even if it could be collected to correspond to school districts, would be subject to local market peculiarities, and would not necessarily be representative of real nonschool alternatives. Only a full-blown price index would necessarily do the job. Since constructing such an index would be a job far beyond the scope of this study, SAL will be used as, perhaps, the best readily available approximation.

The Background Factors

The first half of the noncognitive questionnaire given to students was made up of questions regarding the background of the student.⁷ The Assessment analysts found these to break down, under factor analysis, into two clusters of questions. One scale was interpreted to be a measure of "family solidarity." Questions related to the number of children and adults in the family, who acted as the student's father and mother, whether his parents owned a house and whether they had lived in the area for a long time. Children who lived with both natural parents, with no other adults and no siblings, and whose parents had owned the same house for several years, would have ranked highest on this scale. The other scale included questions on the education of the student's parents, the size of their house,

⁷The following relies heavily on: Educational Testing Service, Technical Report The Ninth Report of the 1970-71 Michigan Educational Assessment Program (Lansing: Michigan Department of Education, June 1972).

and their ownership of items from a dishwasher to a typewriter. The children with the most educated parents and the greatest affluence would have had the highest scores on this scale. This scale was characterized as "educational-economic advantage." The "family solidarity" and "educational-economic advantage" scores were averaged for the total "socio-economic status" (SES) figure available in the data.

Again, as in the case of teacher attributes discussed above, these measures are only proxies for the actual family influences on children. It is possible that extreme enough poverty, a broken home, or some other serious problem may have a direct, disruptive effect on a child's performance. In the main, though, the measures included in the SES index represent more subtle influences. They give a composite picture of the kind of background that reinforces a child's performance. The ownership of a typewriter, for example, is certainly not casually related to output in the sense that distributing typewriters to needy families would increase output. But the ownership of a typewriter is indicative of a background that values cognitive skills. This background attitude may translate into family and general environmental support which enables the child to perform better in school; it may also have its effect through the community's influence on what schools do (see pages 21-24, above).

The SES measure available for individual districts is an average for the students in the districts. This measure, then, must be interpreted as describing the community as a whole. But, of course, not all students are at the mean. The heterogeneity of the community may well be as important as its average SES. This heterogeneity

will be represented by the standard deviation of SES (SES SD). The racial composition of the community may be important, too, for cultural reasons, and will be represented by the percentage of white students (PCT WHITE). Additionally, the size of the district will be represented by the total number of students in the district (SIZE).

Dummy variables will be included to represent both community type and region of the state. The five community types are metropolitan core city, city, town, urban fringe and rural; the four regions are the Detroit area, the rest of the southern half of lower Michigan, the northern half of lower Michigan and the upper Peninsula.

Individual student ability and educational background are not represented. The assumption implicit in omitting ability is that the distribution of ability is the same in all districts. While assuming individual ability to be equal for all students would be an heroic assumption, it seems somewhat more reasonable that districts would have high, middle and low ability students in about the same proportions. If, instead, ability is inherited and associated with something like income or class, SES will tend to pick it up along with environmental effects.

Clearly, the assumption that all districts are the same with respect to student background is unrealistic. This assumption suggests that all districts had done equally well up until the present year, all district differences occurring in the fourth. Or, it might be that children had moved among districts in an essentially random manner so that the backgrounds in each district represent the past effects of a variety of districts. But, while some children do move among

districts, they probably move among similar districts and they probably represent a small enough proportion of the whole that the district's overall educational background can be represented by its educational output up until this year. The lack of even this information is a serious deficiency. Furthermore, not knowing educational levels at the beginning of the test year makes it impossible to measure the changes that take place in that year. The educational levels at the time of the tests will have to be used as the outputs. This substitution amounts to using the outputs of the first four years, rather than of just the fourth. To do so could cause distortions if many districts have changed character drastically in the last four years. Otherwise, the main problem is a likelihood of overstating the effects of current inputs or dollars by attributing four year differences in outputs to a single year.

The Outputs

Turning to the outputs themselves, academic, or cognitive achievement is measured by a "basic skills" test.⁸ The test includes separate, timed sections on vocabulary, reading, mechanics of written English and mathematics. Mechanics of written English is further divided into sections on spelling, effectiveness of written expression, written usage and punctuation and capitalization. The test was constructed in cooperation with the Educational Testing Service, and was screened in advance by a variety of Michigan teachers and education specialists.

⁸ Ibid.

A raw score was computed for each of the four tests by counting correct answers. Each score was then "standardized" to a scale with mean fifty and standard deviation ten. While raw scores are dependent on the length and difficulty of the individual tests, the standardized scores are not, and are directly comparable. The composite score, then, is an average of the last three standardized scores. Vocabulary was omitted from the composite on the theory that it responds more slowly to school influences, and is, thus, not indicative of current school effectiveness. The tests appear to have high validity and reliability. The reliability of the composite score was reported to be .96.⁹ The composite cognitive achievement score (COGNITIVE SCORE) will be used in the present study since it probably represents this aspect of fourth grade education quite well.

Three attitude measures were determined, along with the background measures, by the untimed, noncognitive questionnaire.¹⁰ The Assessment analysts divided the attitude questions, by factor analysis of the responses of a large, random sample, into clusters which measure the same characteristics. Weights were determined by the contribution of each question in the cluster. The process was done initially for fourth and seventh grades separately, but the strong similarity between the two sets of weights led the analysts to combine the two grades. Thus, the final weights are the result of analyzing the two grades together.

⁹Ibid. The scores in each district were divided in half, randomly, and an average was calculated for each half. The coefficient of reliability is just the correlation coefficient between halves.

¹⁰Ibid.

Four clusters of questions resulted from the analysis. The first included questions asking the student how good a student he wanted to be, generally, and in specific subjects like reading and mathematics. Also included were questions as to how good a student each of his parents wanted him to be. Possible responses ranged from "(A) One of the best in my class" (four points) to "(D) Just good enough to get by" and "(E) I don't know" (one point). The resulting scale measures the student's perception of the importance of school achievement, or his desire to do well (DESIRE TO DO WELL).

The second group of questions asked if the student liked school in general, and certain subjects in particular. Also included was whether the student liked to talk to his parents about school. Answers were "(A) Yes" (one point), "(B) No" (no points) and "(C) I'm not sure" (one half point). On another question, "How often do you tell your parents about things that happen in school?" answers ranged from "(A) Just about every day" (three points) to "(D) Never or hardly ever" (no points). The resulting scale is a measure of the student's attitude toward, or liking of school (LIKING SCHOOL).

The third scale resulted from questions regarding the student's perception of his own ability, and included: "How good a student are you?", "Can you do many things well?" and "Do you sometimes feel you can't learn?" (scored for a negative response). Answers to the first were the same as in DESIRE TO DO WELL above. The rest were "(A) Yes," "(B) No," "(C) I'm not sure." This scale measures self perception (SELF PERCEPTION). The fourth cluster of questions, measuring something like "general adjustment," was not reported.

The Assessment analysts claim reasonably high validity for the attitude measures, though they offer no substantiation.¹¹ The reliability of the measures, however, may not be very high. Since the tests were given only once, no direct measure of reliability was possible. Instead, the analysts randomly divided the students in each school in half, and found the mean for each. They used the correlation between halves as an estimate of the reliability of the measures. The result was only about .5.¹² The analysts point out that the measures are not necessarily this unreliable. In fact, they consider this figure as only a lower bound. The two halves may not have been equivalent in all respects.

Apparently, the analysts did not actually consider these three attitude measures to be outputs of schools. At least, they have not ranked districts on these attitudes as they have on cognitive achievement. But these attitudes do correspond reasonably well to goals listed as desired by schools. For example, in the Pennsylvania list given earlier, COGNITIVE SCORE corresponds to goal three "help[ing] every child acquire to the fullest extent possible for him mastery of the basic skills in the use of words and numbers."¹³ But in addition, DESIRE TO DO WELL and LIKING SCHOOL together seem to represent goal four: "help[ing] every child acquire a positive attitude toward school and toward the learning process."¹⁴ And SELF PERCEPTION corresponds,

¹¹Ibid.

¹²Ibid.

¹³Campbell, et al., op. cit.

¹⁴Ibid.

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at least partially, to goal one: "help[ing] every child acquire the greatest possible understanding of himself and an appreciation of his worthiness as a member of society."¹⁵ The Michigan list includes similar goals.

The hypotheses of the last chapter were stated, instead, in terms of Downey's list of goals. COGNITIVE SCORE, of course, corresponds to "the 3 R's," an "intellectual" output. SELF PERCEPTION, while measured in terms of self-perceived school ability, is probably much more a general measure of emotional well-being, a "personal" output. The other two are somewhat ambiguous. DESIRE TO DO WELL certainly has a relationship to "desire to learn more,"¹⁶ an "intellectual" output, but the emphasis on school performance rather than on learning suggests the elements of a "social" output as well. That is, the measure also reflects the degree to which success has come to be perceived according to institutionalized norms. For the purposes of testing the hypotheses of Chapter II, though, it must be assigned to either the "intellectual" or the "social" category, and the former seems the more appropriate. LIKING SCHOOL, on the other hand, suggests not just an acceptance, but an enjoyment of the social institution most relevant to the child, outside the family. In this case, the "social" content probably outweighs the "intellectual." Together, these outputs, representing "intellectual," "social" and "emotional" goals of education, do not span the possibilities nearly as well as one would like. Specifically, one would like to represent the "physical," "moral,"

¹⁵Ibid.

¹⁶Downey, op. cit.

"consumer" and "vocational" goals chosen by those of lower socio-economic status. But even without these, the outputs represented here give a much more complete picture of education than is possible with any single educational output (see pages 24-33, above).

Measures to be Used

The Inputs:

TEACH/PUP
 NONTEACH/PUP
 AV EXPER
 PCT MASTERS
 PCT MALE
 PCT ELEM

The Background Factors:

SIZE
 SES
 SES SD
 PCT WHITE
 COMMUNITY TYPE
 REGION

The Financial Data:

INSTR
 SEV
 SSA
 ESEA
 FED OTH
 AV SAL
 SAL

The Outputs:

COGNITIVE SCORE
 DESIRE TO DO WELL
 SELF PERCEPTION
 LIKING SCHOOL

CHAPTER IV

TESTS OF THE HYPOTHESES

Introduction

The previous chapter has laid out specific data to be used in testing the hypotheses of the theory chapter, summarized on pages 33-35. This chapter identifies the statistical tests that will be used to support or reject each hypothesis. It will be convenient to refer to the summary on pages 33-35 to identify hypotheses, though the specific tests of these hypotheses will have to be conducted in a somewhat different order. Indeed, this chapter ends with a restatement of that summary, entirely in terms of statistical relationships between specific variables in the data.

Determination of Purchased Attributes and Estimation of SAL

The first step in testing the model is to regress AV SAL on the attributes of teachers. The purpose is twofold. First, if school districts value certain attributes, the districts should pay more for them and variations in these qualities should be positively related to the variation in AV SAL. Thus, the regression will indicate which teacher attributes are, in fact, being purchased. Secondly, the regression results allow estimation of what salaries would have been, had each district hired the same amounts of teacher attributes. This

estimate is the SAL variable which will be used as a price level index in what follows.

One approach would be to regress the actual values of the explanatory variables on AV SAL. Instead, the regression will be run using variations from the mean. Econometrically, the two procedures are equivalent; the coefficients of the explanatory variables are not affected. The constant terms are different, though, reflecting the mean AV SAL with zero attributes in the former case, and the mean AV SAL with mean attributes in the latter. Since SAL is to represent district salary level with mean teacher attributes, it can be calculated somewhat more directly in the latter case, simply by subtracting the attribute terms, leaving only the constant and the error term. Thus, the regression will be:

$$\begin{aligned} \text{AV SAL}_i = a_0 + a_1 \text{AV EXPER}_i^* + a_2 \text{PCT MASTERS}_i^* \\ + a_3 \text{PCT MALE}_i^* + e_i, \end{aligned} \quad (4.1)$$

where i represents the individual district and the stars indicate the use of variations from the mean. SAL, then, will be calculated for each district as:

$$\begin{aligned} \text{SAL}_i = \text{AV SAL}_i - [a_1 \text{AV EXPER}_i^* + a_2 \text{PCT MASTERS}_i^* \\ + a_3 \text{PCT MALE}_i^*], \end{aligned} \quad (4.2)$$

and can be interpreted as an estimate of the average salary that would have obtained, if the district had been purchasing the mean amounts of

the teacher attributes. It will be used as a price level index in the cost function estimates.

Hypothesis two, on page 34, is that both experience and additional education are, in fact, purchased attributes. These attributes are represented in equation (4.1) by AV EXPER and PCT MASTERS, respectively. As explained already, if they are being purchased, variations in these attributes should be positively related to the variation in AV SAL. Thus, hypothesis two will be supported if coefficients a_1 and a_2 are positive. If either one is not significantly positive, the attribute associated with it is not being purchased and that part of the hypothesis will be rejected. Similarly, the first part of hypothesis three is that a pay differential exists in favor of males. If such a differential exists, the variation in PCT MALE should be positively associated with the variation in AV SAL. Thus, this part of hypothesis three will be supported if coefficient a_3 is positive; otherwise it will be rejected.

Production Function Estimation

The next step is to estimate the production functions for the hypothesized outputs: COGNITIVE SCORE, DESIRE TO DO WELL, SELF PERCEPTION and LIKING SCHOOL. The basic form of the functions will be a generalized Cobb-Douglas, estimated by regressing the natural logs of the outputs on the natural logs of the explanatory variables. Each output will be treated, first, as if it were the sole output, regressed on school inputs--TEACH/PUP, NONTEACH/PUP, AV EXPER, PCT MASTERS, PCT MALE and PCT ELEM--and on background factors--SIZE, SES, SES SD and

PCT WHITE. The production function for COGNITIVE SCORE, for example, will be:

$$\begin{aligned} \text{COG SCORE}_i = a_0 \cdot [\text{TEACH/PUP}_i^{b_1} \cdot \text{NONT EACH/PUP}_i^{b_2} \cdot \text{AV EXPER}_i^{b_3} \\ \cdot \text{PCT MASTERS}_i^{b_4} \cdot \text{PCT MALE}_i^{b_5} \cdot \text{PCT ELEM}_i^{b_6} \\ \cdot [\text{SIZE}_i^{d_1} \cdot \text{SES}_i^{d_2} \cdot \text{SES SD}_i^{d_3} \cdot \text{PCT WHITE}_i^{d_4}] \cdot e^{u_i}. \end{aligned} \quad (4.3)$$

Equation (4.3) will be estimated by ordinary least squares (OLS) in log linear form. Production functions for each of the other outputs will be estimated in the same way. This specification, then, is roughly equivalent to that of a number of previous studies, which actually have assumed a single output.

Next, each production function will be reestimated, including the other outputs as explanatory variables. This specification allows outputs to affect each other, essentially, by treating the other outputs in each case as inputs. The production function for COGNITIVE SCORE, for example, becomes:

$$\begin{aligned} \text{COG SCORE}_i = a_0 \cdot [\text{DESIRE} \dots \text{}_i^{a_1} \cdot \text{SELF PERCEP}_i^{a_2} \cdot \text{LIKING SCH}_i^{a_3}] \\ \cdot [\text{TEACH/PUP}_i^{b_1} \cdot \text{NONT EACH/PUP}_i^{b_2} \cdot \text{AV EXPER}_i^{b_3} \cdot \text{PCT MASTERS}_i^{b_4} \cdot \text{PCT MALE}_i^{b_5} \\ \cdot \text{PCT ELEM}_i^{b_6}] \cdot [\text{SIZE}_i^{d_1} \cdot \text{SES}_i^{d_2} \cdot \text{SES SD}_i^{d_3} \cdot \text{PCT WHITE}_i^{d_4}] \cdot e^{u_i}, \end{aligned} \quad (4.4)$$

which again can easily be estimated by OLS in log linear form. The production functions for the other three outputs will each have COGNITIVE SCORE as one of the explanatory variables.

Since the other outputs in each case are not exogenous, though, the two stage least squares (2SLS) technique is really more appropriate. This technique, unlike OLS, allows for the fact that the other outputs in each equation are, themselves, dependent on the exogenous variables in the system. Thus, each of the previous production functions will be reestimated with 2SLS instruments for the other three outputs. Equation (4.4), for example, still represents the production function for COGNITIVE SCORE, to be estimated again by logs, but this time with 2SLS instruments for DESIRE TO DO WELL, SELF PERCEPTION and LIKING SCHOOL. The exogenous variables used in the 2SLS estimation but not in the production functions are the per pupil values of state equalized valuation, state school aid, elementary and secondary education act funds and other federal funds, along with SAL and the dummy variables for region and community type. There are twelve such excluded variables and only three endogenous variables to be estimated, so the necessary condition for the equations to be at least identified, that the excluded variables outnumber the endogenous explanatory variables by at least one, is easily met.¹

In terms of a broader model, the school inputs as well as their outputs are determined endogenously. Thus, the production functions also will be estimated using 2SLS instruments for all but the background factors. The same twelve variables are excluded from the equations. Since there are still only nine endogenous explanatory variables, the counting criterion is still met. Of course, the counting

¹J. Johnston, Econometric Methods (New York: McGraw-Hill, Inc., 1963), pp. 240-252.

criterion assumes all excluded variables to be relevant and independent; if not, then counting them would be incorrect and the system might not be identified after all. Such a possibility seems especially relevant in this last set of 2SLS estimates, with so many endogenous variables involved. Phi ratios will be used to test for the problem. The phi ratio tests the probability of identification by means of the variance ratio, which measures the impact that the excluded information would have had on the sum of squared errors. If it would have had no effect, the variance ratio will be one--the phi ratio will be zero, indicating underidentification. A phi ratio significantly different from zero indicates probable identification.² Thus, phi ratios will be very important in deciding which of the 2SLS estimates to use. The estimates treating both inputs and outputs as endogenous will be used if their phi ratios are significant. Otherwise, the estimates treating only the other outputs as endogenous will be used as the basis for testing hypotheses.

A few words need to be said about the effects of using averages instead of individual student data. If the production (and cost) functions were linear, the effects would be straightforward. The estimates would be unbiased. While heteroskedasticity would be introduced, its effects would probably be quite small with so many district observations. Even this problem could be eliminated, though, simply by weighting the data for each district by $\sqrt{N}$, where N is the number of individuals in the average.³ However, since the production

²Ibid., pp. 263-264.

³Brown and Saks ran both weighted and unweighted regressions in preparing their paper, and found essentially no difference in the results. Byron W. Brown and Daniel H. Saks, op. cit.

(and cost) functions are logarithmic, the econometric problems are quite different. The functions fitted with average data are only approximations of the functions fitted with individual data, and they are biased ones at that. That is, assuming $E(u_i) = 0$, making estimates with individual data unbiased, then for averages, $E(\ln \Sigma^N u_i) = \ln N$, indicating a bias when using average data. The result of the bias turns out to be predictable, though. One of the explanatory variables, SIZE, is almost perfectly correlated with N (their correlation coefficient is .9985), and will pick up the effect of the bias. So, while not much should be made of the SIZE coefficient estimates, the other coefficients should not be affected. Because of the complicated error term, it is difficult to determine whether heteroskedasticity is, even theoretically, introduced. If it is, the weighting scheme above is not apt to be appropriate. Technically, heteroskedasticity would open up the t-statistics to question. With so many district observations, though, there is good reason to expect that its effects would be quite small. Therefore, the problem will not be pursued further.⁴

Hypothesis one (pages 33-34) is that all the purchased inputs have positive effects on all the outputs. Teachers per pupil and non-teaching professionals per pupil are both purchased inputs. They are represented in production function (4.4) by TEACH/PUP and NONTEACH/PUP, respectively. Hypothesis one, then, requires that b_1 and b_2 , the regression coefficients for these variables, both be positive in

⁴The author is indebted to Ronald Tracy and Thomas Chester for their help with the econometric tests and problems of the last two paragraphs. The author, of course, is responsible for their final interpretation.

production function (4.4) and in the comparable production function estimates for the other three outputs. Of course, hypothesis two is that experience and additional education are also purchased. If Hypothesis two is supported (see previous section), hypothesis one requires that AV EXPER and PCT MASTERS also have positive effects on all outputs; b_3 and b_4 will also need to be positive in production function estimates for the four outputs.

Hypothesis three is that a pay differential exists in favor of males, but that there is no difference in productivity. The previous section established a test for the first part--that a pay differential exists in favor of males. The second part--that there is no difference in productivity--can be tested with the production function estimates. If this part of the hypothesis is correct, then variations in PCT MALE should not be associated with variations in outputs. Thus, the second part of hypothesis three will be supported if b_5 is not significantly different from zero for all four outputs.

The final "school input" in equation (4.4) is PCT ELEM. This measure does not relate directly to the hypotheses on pages 33-35. but is included to help correct for a deficiency of the data. Input measures are averages over all grades. A district concentrating relatively more of these inputs on the elementary grades should get more fourth grade output than a district concentrating relatively more on the upper grades. PCT ELEM represents the concentration on the elementary grades, and should be positively related to outputs. The coefficient b_6 should be positive.

The major hypotheses of this study are that schools choose to produce different outputs, consistent with community preferences, and that it is this choice, not differential ability, that leads to the large background effects on individual outputs. Since high SES and PCT WHITE districts are predicted to emphasize intellectual goals relatively more, hypothesis 4a is for them to appear more productive in production functions including only intellectual outputs. COGNITIVE SCORE and DESIRE TO DO WELL are the available intellectual output measures. Thus, hypothesis 4a will be supported if d_2 and d_4 , for SES and PCT WHITE, are both positive in production function (4.3) with COGNITIVE SCORE as the only output, and if the same is true in the comparable production function estimate with DESIRE TO DO WELL as the only output. Hypothesis 4b is merely the converse of 4a; the same districts emphasizing the intellectual outputs relatively more will be emphasizing the other outputs relatively less. Thus, hypothesis 4b will be supported if these same coefficients, d_2 and d_4 , are negative in the comparable production function estimates for SELF PERCEPTION and LIKING SCHOOL alone.

If the major hypotheses are correct, the results predicted by hypotheses 4a and 4b are due to misspecification of the production functions. Effects due to choice do not belong in a production function, but enter because the form of equation (4.3) does not allow the levels of the other outputs to enter. Thus, hypothesis 4c is that background effects will become insignificant with the inclusion of all outputs. Specifically, hypothesis 4c will be supported if d_2 and d_4 , for SES and PCT WHITE, are not significantly different from zero in

the multiple output production function (4.4) and in the comparable production function estimates, with the other outputs as the dependent variables.

For choice to be central, of course, the outputs cannot be produced in fixed proportions--they must be substitutes. Hypothesis 4d specifies the relationships to be expected among the outputs. Since COGNITIVE SCORE and DESIRE TO DO WELL are both intellectual outputs, they may be complements in production and have positive effects in each other's production functions; SELF PERCEPTION and LIKING SCHOOL also may have positive effects on each other. In all other cases, though, the outputs are hypothesized to be substitutes, and should have negative effects in each other's production functions. For example, in production function (4.4) for COGNITIVE SCORE, hypothesis 4d will be supported if a_1 , for DESIRE TO DO WELL, is positive and a_2 and a_3 , for SELF PERCEPTION and LIKING SCHOOL, are both negative.

All the hypotheses of the theory chapter have now been interpreted in terms of multiple output production function (4.4)--and the comparable ones for the other three outputs--except hypotheses 4a and 4b, which relate to background effects in single output production function (4.3)--and the related ones for the other outputs. Indeed, all the coefficients in equation (4.4) have been predicted, except d_1 and d_3 , the coefficients for SIZE and SES SD. There are no a priori hypotheses for these. As pointed out above, the SIZE coefficient is likely to be biased in any case.

Cost Function Estimation

The production function estimates suffer from a real weakness in input data. A great many other inputs are purchased by districts, for which data are simply not available. Cost function estimates have a real advantage in terms of available data. Furthermore, as explained in the theory chapter, cost functions provide the relevant constraint on choice, anyway, allowing districts to substitute in a rational way among inputs, depending on their choice of outputs. Thus, cost functions provide a better test of the major hypotheses than do the production functions estimated above. The form of the cost function will again be a generalized Cobb-Douglas, estimated by regressing the log of expenditure per pupil on the logs of outputs and background variables. Expenditure per pupil is represented by INSTR; background variables include SAL as well as those in the production function estimates. Each output will be treated, first, as the sole output in the function. For COGNITIVE SCORE, for example, the function will be:

$$\begin{aligned} \text{INSTR}_i = c_0 \cdot [\text{COG SCORE}_i^{c_1}] \cdot [\text{SIZE}_i^{d_1}] \cdot \text{SES}_i^{d_2} \cdot \text{SES SD}_i^{d_3} \\ \cdot \text{PCT WHITE}_i^{d_4} \cdot \text{SAL}_i^{d_5} \cdot e^{u_i}, \end{aligned} \quad (4.5)$$

estimated in log linear form. 2SLS instruments will be used for the outputs; the same exogenous variables will be excluded as before. Cost functions of this form are best thought of as derived from the single output production functions, at least for the purpose of testing the major hypotheses.

Next, a cost function will be estimated including all four of the outputs. This joint output form will be:

$$\begin{aligned} \text{INSTR}_i = c_0 \cdot [\text{COG SCORE}_i^{c_1} \cdot \text{DESIRE}_i^{c_2} \cdot \text{SLF PERCEP}_i^{c_3} \cdot \text{LIKING SCH}_i^{c_4}] \\ \cdot [\text{SIZE}_i^{d_1} \cdot \text{SES}_i^{d_2} \cdot \text{SES SD}_i^{d_3} \cdot \text{PCT WHITE}_i^{d_4} \cdot \text{SAL}_i^{d_5}] \cdot e^{u_i}, \end{aligned} \quad (4.6)$$

estimated again in log linear form with 2SLS instruments for all four outputs. This form of the cost function is best thought of as derived from the joint output production functions such as that estimated in equation (4.4), at least for the purpose of testing the major hypotheses.

A comment is in order on the procedure of estimating production and cost functions independently of each other. Theoretically, the cost function could be derived from the production functions and efficiency conditions, if relative input prices were known. A major impetus for using cost functions, though, is the fear that production function estimates are inadequate. Thus, cost functions based on these production function estimates would not be useful. The only way that cost functions can serve as useful, independent tests of the major hypotheses is if they are estimated independently of the production functions.

Hypotheses 4a-4c can now be restated in terms of cost function estimates. Since high SES and PCT WHITE districts are predicted to emphasize intellectual goals relatively more, hypothesis 4a is for such districts to appear more productive in cost functions including only intellectual outputs. Appearing more productive in cost functions

means having a negative effect on cost, for any given output level. Thus, hypothesis 4a will be supported if d_2 and d_4 , for SES and PCT WHITE, are both negative in cost function (4.5) with COGNITIVE SCORE as the only output, and if the same is true in the comparable cost function estimate, with DESIRE TO DO WELL as the only output. Again, hypothesis 4b is merely the converse of 4a; the same districts emphasizing the intellectual outputs relatively more will be emphasizing the other outputs relatively less. Thus, hypothesis 4b will be supported if these same coefficients, d_2 and d_4 , are positive in the comparable cost function estimates for SELF PERCEPTION and LIKING SCHOOL alone. But, if the major hypotheses are correct, the effects predicted in 4a and 4b are due to having excluded the other outputs from each of these cost functions. Hypothesis 4c is that that background effects will become insignificant with the inclusion of all outputs. Specifically, hypothesis 4c will be supported if d_2 and d_4 , for SES and PCT WHITE, are not significantly different from zero in the multiple output cost function (4.6).

The coefficients c_1 - c_4 , for the outputs in the cost function (4.6), have a real significance as well. All the foregoing has assumed that the four output measures do, in fact, represent outputs sought by schools. Because of the weakness of the input data, even very poor fits for their production functions will not be adequate to refute that assumption. The cost function, though, provides a test. Economic theory requires that an output sought by schools must bear a positive relationship to expenditure. Thus, the assumption that all four of these measures do represent outputs sought by schools will be supported

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if c_1 - c_4 are all positive. If any of these coefficients is negative, though, the corresponding measure must be rejected as an output sought by schools, at least at the margin.

As in the case of the production function estimates, there are no a priori hypotheses for d_1 and d_3 , the coefficients for SIZE and SES SD. On the other hand, d_5 , the coefficient for SAL, can be predicted. SAL is included to represent price level variation among districts. It need not be significant; price level variation among districts may not be all that important. But if it is significant, it must be positive. That is, higher prices must be associated with higher costs, for any given output level. Thus, d_5 must be zero or positive in equation (4.6). A negative coefficient would suggest serious problems with the whole cost function estimate.

Summary

1. Hypothesis one is that all the purchased inputs have positive effects on all the outputs. This hypothesis requires b_1 and b_2 , for TEACH/PUP and NONTEACH/PUP, to be positive in multiple output production function (4.4) and in the corresponding estimates for the other outputs. Furthermore, if hypothesis two is supported, b_3 and b_4 , for AV EXPER and PCT MASTERS, must also be positive in these same estimates.

2. Hypothesis two is that both experience and additional education are, in fact, purchased attributes. This hypothesis requires a_1 and a_2 , for AV EXPER and PCT MASTERS, to be positive in equation (4.1), indicating a positive effect on AV SAL.

3. Hypothesis three is that a pay differential exists in favor of males, but that there is no difference in productivity. The first part is supported if a_3 , for PCT MALE, is positive in equation (4.1); the second part is supported if b_5 , for PCT MALE, is zero in multiple output production function (4.4) and in the corresponding ones for the other outputs.

4. The major hypotheses are that schools choose to produce different outputs, consistent with community preferences, and that it is this choice, not differential ability, that leads to the large effects of background factors on individual outputs. In support of these general hypotheses, the specific predictions are for:

a. coefficients d_2 and d_4 , for SES and PCT WHITE, to be positive in single output production function (4.3) for COGNITIVE SCORE, and in the corresponding estimate for DESIRE TO DO WELL; and these same coefficients to be negative in single output cost function (4.5) for COGNITIVE SCORE, and in the corresponding estimate for DESIRE TO DO WELL;

b. these same coefficients to have the opposite signs from those above in the corresponding production and cost function estimates for SELF PERCEPTION and LIKING SCHOOL alone;

c. these same coefficients to be zero in multiple output production function (4.4) and in the corresponding ones for the other outputs, and in multiple output cost function (4.6).

d. the a_i 's, for the outputs, all to be negative in multiple output production function (4.4) and related estimates, except for those relating COGNITIVE SCORE with DESIRE TO DO WELL

and those relating SELF PERCEPTION with LIKING SCHOOL; and the c_j 's,
for the outputs, all to be positive in multiple output cost function
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CHAPTER V

THE RESULTS

Introduction

Chapter IV has identified specific equations to be estimated, and has predicted many of the coefficients. This chapter presents the estimates, and examines them for consistency with these predictions. In cases for which the results conflict with the predictions, the implications of these differences will be explored. Again, it will be convenient to refer to the foregoing summaries to identify hypotheses. And again, this chapter closes with a restated summary, this time indicating the results with respect to each hypothesis.

Determination of Purchased Attributes and Estimation of SAL

The first step is to estimate equation (4.1) of the previous chapter. The result is:

$$\begin{aligned} \text{AV SAL}_i = & 9194.05 + 27.92(\text{AV EXPER}_i - 9.32) + 51.26(\text{PCT MASTERS}_i - 21.65) \\ & \quad (1.72) \quad (14.64) \\ & - .13(\text{PCT MALE}_i - 37.14) + \hat{e}_i, R^2 = .3116, \\ & \quad (-.03) \end{aligned} \quad (5.1)$$

where i represents the individual district, the large parentheses contain the differences from the mean and the t -statistic is given under each coefficient. As predicted, the coefficients for AV EXPER and PCT MASTERS

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are both significant at, at least, the .05 level for a one-tailed test. The one-tailed test is appropriate because of the a priori expectation that the coefficients, if significant, are positive. Thus, hypothesis two, that experience and additional education are purchased attributes, is immediately supported. In the subsequent tests of hypothesis one, these two attributes, as well as teachers and nonteaching professionals per pupil, constitute the purchased inputs that must have positive effects on all outputs. Contrary to the first part of hypothesis three, however, the coefficient for PCT MALE is not significantly different from zero. Thus, the first part of hypothesis three must be rejected; there is no evidence for a wage differential between male and female teachers, other things equal.

As explained previously, the foregoing estimates are potentially biased upward, both because other teacher attributes are omitted, and because of possible labor market disequilibria. Indeed, equation (5.1) can be manipulated to show an average \$5126 cost for one additional masters' degree, total number of teachers constant. This is certainly much too high. PCT MASTERS may be correlated with other attributes, not included in the equation, like verbal ability and, especially, other aspects of teacher training, which are also valued by schools. Years of additional schooling would be an obvious example. Furthermore, 1969-71 represents a period in which the transition from a shortage to a surplus of teachers may have made market disequilibria especially important. Thus, it would be wrong to make too much of equation (5.1). Its use is justified mainly as the best available method of approximating district price level. And in the process, it offers fairly

strong evidence that AV EXPER and PCT MASTERS are being purchased and that PCT MALE is not. These broad results, not the specific values, are the important conclusions from equation (5.1).

The original regression, repeated without the significant explanatory variable, gives:

$$\begin{aligned} \text{AV SAL}_i &= 9194.05 + 27.87(\text{AV EXPER}_i - 9.32) \\ &\quad (1.72) \\ &\quad + 51.27(\text{PCT MASTERS}_i - 21.65) + \hat{e}_i, \\ &\quad (14.70) \\ R^2 &= .3116. \end{aligned} \tag{5.2}$$

SAL, then, is calculated for each district, i , as:

$$\begin{aligned} \text{SAL}_i &= \text{AV SAL}_i - [27.87(\text{AV EXPER}_i - 9.32) \\ &\quad + 51.27(\text{PCT MASTERS}_i - 21.65)]. \end{aligned} \tag{5.3}$$

Production Function Estimation

Tables 1-4 present estimates of the production functions. The first columns give OLS estimates, each on the assumption that the dependent variable is the sole output. Column one of Table 1, for example, gives the coefficients for equation (4.3) of the previous chapter. The second columns give OLS estimates, this time including the other outputs in each case as inputs. Thus, column two of Table 1 gives OLS estimates of the coefficients for equation (4.4). The final columns give estimates of the coefficients for these same production functions, including the other outputs in each case; 2SLS estimators are used here, though, to represent the other outputs.

As indicated in Chapter IV, the school inputs, as well as their outputs, are determined endogenously. Thus, the production functions were also estimated using 2SLS instruments for all but the background factors (see Appendix, Tables A1-A4). The results changed greatly, but with a general loss of significance. The phi ratios, indicating identification, became insignificant. In the production function for COGNITIVE SCORE, for example, the significance level for the phi ratio is at least .0005 when 2SLS instruments are used only for the other outputs. When 2SLS instruments were used for all but the background factors, though, the significance level was only .751. The same effect took place in the production functions for both DESIRE TO DO WELL and SELF PERCEPTION. Only in the case of LIKING SCHOOL was the effect reversed, reflecting mainly the low significance of the phi ratio in either case. Thus, for LIKING SCHOOL, all the 2SLS estimates must be considered somewhat suspect. In the other three cases, though, the estimates with 2SLS instruments only for the outputs are clearly superior and the others, with 2SLS instruments for all but background factors, will not be treated further. While the counting requirements for identification were satisfied, evidently there is, in fact, just not enough independent information to support so many endogenous variables.

The important results, then, are the estimates of the production functions given in Tables 1-4. The next few paragraphs describe the specific estimates. The following discussion will examine these results in the light of previous predictions. Purchased inputs and PCT ELEM should be positively related to all outputs, so one-tailed

tests are appropriate. Effects of SES and PCT WHITE have been predicted in each case, as have the interrelationships among outputs, so one-tailed tests will be used for these too. Two-tailed tests will be used for PCT MALE, SIZE and SES SD. In addition, for cases in which the sign runs counter to expectation, the result will be assessed in terms of whether it would have been significant according to a two-tailed test. Differences between the first two columns and the third will be used to infer the extent to which biases result from ignoring multiple outputs, especially with respect to the relative importance of background factors. Finally, the effects across equations of specific inputs and background factors will be examined, along with the trade-offs among outputs implied in the different production functions.

Consider first (Table 1) the OLS estimates of the production function for COGNITIVE SCORE. AV EXPER has the greatest effect among purchased inputs but both PCT MASTERS and TEACH/PUP also have significant positive effects. Contrary to expectation, though, NONTEACH/PUP shows a strong negative effect. The strong (negative) effect of PCT MALE is also surprising. Among background factors, SES and PCT WHITE both show the predicted positive relationship to output; district SIZE shows a negative effect. Among the other outputs, included in column two, LIKING SCHOOL and SELF PERCEPTION both show positive rather than negative relationships to COGNITIVE SCORE, but the relationships are not significant at the .10 level.

The lower efficiency of the 2SLS method is reflected in the generally lower t-statistics of column three; the coefficients, on

the other hand, are generally similar to those obtained through OLS. The striking exceptions are for the attitude outputs themselves. The coefficients for all three become much larger. DESIRE TO DO WELL now shows the predicted positive relationship. LIKING SCHOOL also shows a positive, and SELF PERCEPTION, a negative effect, but their t-values are low. The changes in these coefficients reflect the existence of other relationships involving the attitudes and the other explanatory variables. These relationships should be captured in the other production functions.

The OLS estimates for DESIRE TO DO WELL show PCT ELEM to be the only school input with a significant positive effect. Contrary to expectation, PCT MASTERS shows a strong negative effect. The coefficient for PCT MALE is again negative, though this time it is not quite significant. SES again shows the expected positive effect. Surprisingly, the effect of PCT WHITE is negative. SIZE has a positive influence in this case. Among the other outputs, LIKING SCHOOL shows the expected negative relationship.

Again, the introduction of 2SLS estimators for the other outputs greatly increases the size of their coefficients. Both COGNITIVE SCORE and LIKING SCHOOL show the relationships predicted. And again, while the t-statistics for the background and school variables generally decline, the coefficients of most do not change much. The important exception is SES. When the other relationships are allowed for, the effect of SES becomes insignificant. This change, of course, is as predicted.

The OLS estimates for SELF PERCEPTION show PCT MALE and PCT ELEM to have the only significant school effects, and both effects are negative. PCT WHITE shows the predicted negative effect, but the effect of SES is strongly positive. COGNITIVE SCORE is the only output to be even marginally significant, and its sign is positive instead of negative. A number of changes occur when 2SLS estimation is used. The coefficient for PCT MASTERS becomes significant. The effect of COGNITIVE SCORE becomes negative but insignificant. The coefficients of both attitude measures increases greatly, though neither becomes significant. Importantly, the rather substantial effect of PCT WHITE disappears. Again, this change is as predicted.

In the OLS estimates for LIKING SCHOOL, AV EXPER shows the proper relationship to output; NONTEACH/PUP and PCT ELEM show negative effects. PCT WHITE has the predicted negative influence. Among the other outputs, DESIRE TO DO WELL has the expected negative effect. In this case, the 2SLS estimate shows no striking differences.

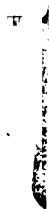
Hypothesis one, that all the purchased inputs have positive effects on all outputs, must be rejected; clearly, the production process is much more complex. The various inputs are related differently to each of the four outputs. TEACH/PUP has an effect only on COGNITIVE SCORE. AV EXPER has a very strong effect on COGNITIVE SCORE, but little effect elsewhere. PCT MASTERS is the one input to show a pervasive influence across production functions. It has significant positive effects on COGNITIVE SCORE and SELF PERCEPTION, but these are partially offset by negative effects on DESIRE TO DO WELL and (marginally) LIKING SCHOOL. The implication is that the

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first two, and not the others, represent the goals stressed by teacher education programs. PCT MASTERS is also the only input that actually gains significance in the 2SLS estimates. Probably this result reflects the tendency of its positive and negative effects simply to cancel out in the OLS estimates.

NONTEACH/PUP, on the other hand, while not always significant, shows a consistently negative relationship to outputs. A purchased input may have a negative relationship to some outputs, borne as a cost for its positive effect on other outputs. PCT MASTERS, above, shows this pattern. But it should not have a negative effect on all outputs. Such a result implies that districts would have better not purchased the input, at least at the margin. Perhaps the causation is really the other way around. At least some of these nonteaching professionals are remedial personnel who are concentrated in low output districts in response to these low outputs.

The second part of hypothesis three, that there is no difference in productivity between male and female teachers, must also be rejected. PCT MALE shows an across the board negative influence, despite the fact, established earlier, that it (or its complement, PCT FEMALE) is not an attribute for which schools pay. Perhaps there are institutional reasons for this result. First of all, laws prevent much discrimination in pay on the basis of sex. Of course, the conventional wisdom is that these laws protect women, not men, from such discrimination. In this case, it would have been in the school districts' interest to have discriminated against men, because of their



lower productivity. It seems unlikely, though, given past evidence,¹ that the burden of such laws is to protect men from discrimination in favor of women.

Secondly, men and women have traditionally been concentrated at different levels, with women in the lower grades and men in the upper grades. If high percentages of women really only indicate school districts which concentrate on the lower grades, then certainly, the districts with the lower grade emphasis should be the more productive of fourth grade outputs. But it was with this possibility in mind that PCT ELEM was included, to represent lower grade emphasis explicitly.

As it happens, PCT MALE and PCT ELEM are only weakly correlated (their simple correlation coefficient is $-.1803$) and they clearly measure different qualities. To clarify their effects, though, each production function was reestimated excluding, first PCT ELEM, then PCT MALE and then both (see Appendix, Tables A5-A8). The relevant t-statistics are low in most cases. For DESIRE TO DO WELL, though, the effects are as would be expected. The positive effect of PCT ELEM does offset what would, otherwise, have been a stronger negative effect of PCT MALE. Apparently, PCT MALE would have picked up some grade level emphasis, had PCT ELEM not been included. Likewise, PCT ELEM would have picked up some of the effect of PCT MALE, had it not been included. In the other production functions, though, the results require a different interpretation. First of all, the effect of PCT

¹For example, Levin, op. cit.

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ELEM is negative, suggesting that a lower grade emphasis is actually counterproductive of these outputs. Secondly, this negative effect of PCT ELEM strengthens what would, otherwise, have been a weaker negative effect of PCT MALE. That is, apparently, the differential productivity between men and women would be even greater if women were not concentrated in lower grades, where productivity is lower.

The negative effect that PCT ELEM exhibits in some cases is counter to all expectation, and may be the result of having omitted some other input. It is significantly negative in only one case. The burden of the evidence, though, is that the PCT MALE effect is real. Perhaps women do tend to be better teachers of young children. Such a result is certainly conceivable. But, perhaps the difference really reflects discrimination, not in schools, but in alternative employment opportunities. As long as women are discriminated against elsewhere, their opportunity costs as teachers will be lower. Schools will tend to draw from among the most capable women; comparable men will tend to go elsewhere. So, while sex discrimination did not show up where predicted, in the salary data for schools, such discrimination in employment alternatives is probably responsible for the significance of PCT MALE.

The question remains, of why schools would hire these less productive men. The answer may lie in their special effects on boys. Patricia Cayo Sexton has argued that schools tend to be feminine institutions, and that this accounts for the greater problem some boys have in adjusting to them.² She calls for more male teachers

²Sexton, op. cit.

at the lower levels to provide balance, and make schools into more suitable places for boys. While she may carry the argument further than would most educators, many would probably agree that there should be some male teachers in the lower grades. There may be the tendency to accept lower productivity, just to get some men in these positions. Such an argument implies different production functions for boys and girls. That is, while the men are less productive overall, they are actually more productive with at least some boys. It would be interesting to test this idea by separating the production functions for boys and girls, but the present data does not allow the identification of output by sex.

Statistical significance aside, the coefficients for school inputs are all quite small. The two largest school coefficients are those for TEACH/PUP and AV EXPER in the production function for COGNITIVE SCORE. A fifty per cent increase in AV EXPER would increase COGNITIVE SCORE by about two per cent. An equivalent rise in TEACH/PUP would raise COGNITIVE SCORE by about 1.27 per cent. Percentage changes of this magnitude in any of the outputs are more important than they may seem. For a district with the mean COGNITIVE SCORE of fifty-one, a two per cent increase is a rise of about one point, or .4 standard deviations, and would have a very marked effect on its relative ranking. According to Michigan Assessment calculations, a district with a mean score of 51.0 was in the fiftieth percentile, while one with a 52.0 mean was in the sixty-seventh.³ Since the other outputs have comparable

³Local District Results: Michigan Educational Assessment Program (Lansing: Michigan Department of Education, December 1971), pp. 58-81.

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means and standard deviations, a small percentage change would be important for them too. A district with a 49.7 mean in SELF PERCEPTION, for example, was in the fifty-first percentile, while one with 50.7 was in the seventy-fifth. Even by these standards, though, most of the other input effects are very small. PCT MASTERS, while significant, has no coefficient larger than .000068. Even a doubling of this input would change COGNITIVE SCORE by only .0066, and SELF PERCEPTION by .0036 per cent.

By comparison, SES has especially large coefficients in the production functions for COGNITIVE SCORE and SELF PERCEPTION. But since SES is a normalized variable, with mean of 49.8 and standard deviation of only 2.7, it is impossible even to consider percentage changes of the magnitudes above. While school input values of fifty and one hundred per cent above the mean are not only possible, but observed, the maximum value of SES is only 61.4--less than twenty-five per cent above the mean. A change of only ten per cent for a mean district would be extremely large. Of course, even a ten per cent change would change COGNITIVE SCORE by five, and SELF PERCEPTION by 2.7 per cent--still very strong effects. But its small variation relative to other factors makes SES less dominant than a simple comparison of coefficients would suggest.

The effects of PCT WHITE are also potentially very great, despite its somewhat smaller coefficients. The mean PCT WHITE is 95.27 per cent. There are eight districts, though, with less than fifty per cent white, with one having only 11.81 per cent. For some of these lowest districts, a one hundred per cent increase or more

is conceivable, with a very substantial effect on COGNITIVE SCORE. Of course, since the effects on DESIRE TO DO WELL and LIKING SCHOOL are negative, there will be corresponding losses in these outputs. Unfortunately, the potential bias in the coefficient for SIZE precludes any comparable interpretation of its effects.

The effects of SES and PCT WHITE, of course, were the subject of the major hypotheses, broken down into hypotheses 4a-4d. Hypotheses 4a and 4b can be considered together. Both SES and PCT WHITE were predicted to have positive effects in single output production functions for COGNITIVE SCORE and DESIRE TO DO WELL (4a), and negative effects in single output production functions for SELF PERCEPTION and LIKING SCHOOL (4b). For PCT WHITE, these predictions were really quite good. In fact, its effect on DESIRE TO DO WELL is negative; the other effects are as predicted. The difference for DESIRE TO DO WELL suggests that communities with relatively more blacks value this output relatively more, not less, as was hypothesized. The significance of this difference for the overall model, though, is minimal. The results still support the view that communities choose among outputs, getting more of some at the cost of getting less of others. For SES, on the other hand, the results are much more damaging. SES has significant positive effects on COGNITIVE SCORE, DESIRE TO DO WELL and SELF PERCEPTION and it has no negative effects. In this case, the idea of a trade-off is not supported; higher SES districts can have more of everything. Thus, hypotheses 4a and 4b are supported for PCT WHITE, in all but one single output production function. For SES, however, only 4a is supported; there are no negative effects as required by hypothesis 4b.

Hypothesis 4c, that SES and PCT WHITE have no effects in production functions including all outputs, is clearly refuted. In two cases, substantial background effects do disappear as this hypothesis requires. SES becomes insignificant in the production function for DESIRE TO DO WELL; PCT WHITE drops out of the production function for SELF PERCEPTION. These changes, though, represent the exceptions. The substantial nature of the remaining background effects has already been described.

The effects on COGNITIVE SCORE accord fairly well with the results of previous studies. That is, the children in large, poor and black districts tend to score the lowest. On the other hand, their higher DESIRE TO DO WELL suggests that blacks consider education to be a very important means of improving their lot. One would expect this combination of high DESIRE TO DO WELL and low COGNITIVE SCORE to cause other attitude problems, but blacks score no worse than whites in SELF PERCEPTION, and actually score higher than whites in LIKING SCHOOL. If problems arise with respect to these attitudes, it must happen only in the higher grades. Or, perhaps "doing well" involves comparisons only with one's immediate peers. Blacks may compete more intensively--and enjoy doing so--irrespective of how their achievement level compares with that in other districts.

While most of the output coefficients are not significant, at least their signs are consistent among equations. Most are related positively, the exceptions being COGNITIVE SCORE with SELF PERCEPTION and DESIRE TO DO SELL with LIKING SCHOOL. Hypothesis 4d predicted more of the outputs to be substitutes. Specifically, COGNITIVE SCORE

was predicted to be negatively related with LIKING SCHOOL, as was DESIRE TO DO WELL with SELF PERCEPTION. Except in these two cases, though, the relationships predicted in hypotheses 4d are supported. The differences are not very important. The important result is that negative relationships do exist among the outputs. These negative relationships assure that districts do face trade-offs among the outputs. That is, districts must choose between concentrating on COGNITIVE SCORE or on SELF PERCEPTION, on DESIRE TO DO WELL or on LIKING SCHOOL.

These output relationships further complicate the background effects. A rise of ten per cent in PCT WHITE would raise COGNITIVE SCORE about .8 per cent directly, and lower DESIRE TO DO WELL and LIKING SCHOOL by .7 and .4 per cent respectively. But these lowered attitudes would have negative secondary effects on COGNITIVE SCORE, and positive effects on each other, while the higher COGNITIVE SCORE would have positive effects on both of the attitudes. Such complications even extend to SES, with its positive effects on both COGNITIVE SCORE and SELF PERCEPTION, because these two outputs have negative effects on each other.

Summarizing briefly, then, the production functions give, at best, luke-warm support for the theory. Only occasionally do the purchased inputs show the proper relationship to outputs. The attitude production functions are particularly weak in this respect. If these attributes are, indeed, outputs, then clearly the relevant inputs are missing. Furthermore, the estimates do not support the hypothesis that background factors operate solely through choice. In two of the

production functions the evidence suggests that some of the background effect does reflect choice. In the case of DESIRE TO DO WELL, the rather substantial SES effect vanished from the production function when 2SLS estimation was used. The same happened to the PCT WHITE effect on SELF PERCEPTION. But in every case, at least one background factor remained significant. In the production function for COGNITIVE SCORE--the output common to past studies--both SES and PCT WHITE remained significant. Thus, while the production functions clearly indicate the possibility--indeed, the necessity--of choice among outputs, this choice does not account for all of the background influence. Different community types do face different production functions.

Cost Function Estimation

Cost function estimates have an advantage over production function estimates in this case because they do not rely on the suspect input data. They also provide valuable additional information. It is important, of course, to know that different community types face different production functions. But it is probably more important to know whether these different communities can actually buy the same combinations of outputs. This question is still not settled because of the diversity of the background effects among the production functions, and the possibilities for trade-offs among outputs. For example, if districts with high PCT WHITE are better at producing one output, but worse at producing others, are they better or worse off? Clearly, the answer depends in part on the possibilities for

trading off among outputs. The important trade-offs, though, are not those in any one production function, involving, even at its best, just the inputs relevant to a particular output. The important trade-offs are those possible, assuming that districts also switch inputs in a rational way. The multiple output cost function represents these possibilities. Table 5 gives estimates of this cost function, as well as those for each of the outputs individually.

Hypothesis 4d, for all the output coefficients to be positive, is crucial to the interpretation of these results, and will be considered first. The coefficient of LIKING SCHOOL does not satisfy hypothesis 4d and, thus, LIKING SCHOOL must be rejected as an output sought by schools at the margin. The production function for LIKING SCHOOL was, in fact, the weakest of the four, but because of the possible inadequacy of the input data, LIKING SCHOOL could not have been rejected as an output on the basis of the production function estimate alone. The negative relationship to expenditure, though, is definitely inconsistent with the requirements of economic theory. Schools could still be producing it; that is, the total product could still be positive. If so, it must be tied in production to other outputs which still have positive marginal products, and which, apparently, are more highly valued. To get more of these other outputs, then, schools have to carry production into the area of negative marginal product for LIKING SCHOOL. Schools could have had more LIKING SCHOOL with fewer resources. The loss in LIKING SCHOOL represents an additional cost, borne for the positive returns on the other outputs. Alternatively, of course, schools may not be producing LIKING SCHOOL at all. In either case,



it is not sought by schools at the margin. The results for the other three outputs, on the other hand, are entirely consistent with hypothesis 4d.

Hypotheses 4a and 4b were for SES and PCT WHITE to have negative effects in the single output cost functions for COGNITIVE SCORE and DESIRE TO DO WELL, and positive effects in the single output cost function for SELF PERCEPTION. (From now on, estimates for LIKING SCHOOL can be ignored.) Both SES and PCT WHITE show the predicted effects in the case for COGNITIVE SCORE. In all other cases, though, the coefficients are insignificant or have the wrong sign. Thus, hypotheses 4a and 4b are generally not supported in single output cost functions.

Hypothesis 4c, for background effects to disappear in the cost function including all outputs, is supported for PCT WHITE. In the previous test of this hypothesis, using production functions, the effects of PCT WHITE did not disappear as predicted. The sign of the PCT WHITE coefficient, though, was positive for COGNITIVE SCORE and negative for DESIRE TO DO WELL. It was not clear whether either high or low PCT WHITE districts had an overall advantage. The implication of the cost function result is that the two effects tend to cancel out. Its effects in production functions notwithstanding, PCT WHITE does not effect the cost to communities of these outputs.

Hypothesis 4c is not supported for SES, though. SES shows a significant negative effect in the multiple output cost function. Again this result can be related to the results using production functions. SES showed significant positive effects in two of the

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multiple output production functions. Since it showed no offsetting negative effects, one would have been surprised if its effects had cancelled out. The positive effects in the production functions, of course, imply that fewer school inputs need to be bought, for any given level of outputs. Thus, the positive effects in the production functions are consistent with the negative effect exhibited in the cost function.

As explained above, percentage differences in SES are fairly small because of the way it is measured. The total spread, from 41.4 to 61.4, represents about forty per cent of the mean. Still, the effect of SES is substantial. The cost of offsetting a one per cent deficit in SES is a 2.09 per cent increase in expenditures per pupil. This cost in dollars obviously depends on the expenditure level used as the base. Perhaps the most logical choice for a point of comparison is a hypothetical district of mean SES and mean expenditures. The lowest SES district would need \$660 per pupil--about \$172, or thirty-five per cent more than the mean of \$488--in order for it to face the same output opportunities as the mean SES district with mean expenditures. The highest SES district, on the other hand, would need only \$250 per pupil--about \$238, or forty-nine per cent less than the mean of \$488--in order to have these same opportunities. The adjustment is equal to plus or minus .0209 (\$488), for each per cent that a district's SES is below or above the mean. Since the great majority of districts are well within five points (ten per cent) of the mean SES, though, adjustments of as much as \$100 per pupil would be quite rare.

Effects of this magnitude do not support the contention that society is helpless in the face of overriding background effects. State school aid already varies from \$18.68 to \$562.90 per pupil. Federal revenue, in the form of ESEA aid as well as other federal programs, ranges from zero to \$390.90 per pupil. Such variations, if applied to SES, could entirely compensate for differences in SES. At present, of course, state aid is determined by the state equalized valuation, or wealth, of a community. Such aid recognizes that facing the same cost curve does not assure equality. It would be one thing for communities to buy different amounts of education because of different subjective valuations of education relative to other goods. But wealthier districts can buy more education along with more of all other goods. The state aid formula is an attempt to allow poorer districts to buy the amount of education that they would have bought, had they been wealthier. Such a concern for the effects of wealth is completely legitimate, but it fails to deal with the additional effects of SES. Districts with lower SES levels actually face higher costs for any given amount of education. Intuitively, one might expect SES and state equalized valuation per pupil to be strongly correlated, but, in fact, they are not. Their correlation coefficient is only .08854. State aid is only weakly correlated with SES (-.19067). Federal revenues do only slightly better in compensating for SES. Clearly, if all districts are to face the same output opportunities, school aid formulas should be revised to reflect SES as well as wealth.

The cost function estimates also tend to refute the contention that the marginal products of schools are very nearly zero. The cost of raising the mean district's COGNITIVE SCORE from 51.0 to 53.5--a rise of one full standard deviation--is about a 13.5 per cent rise in expenditures. Based on a mean of \$488, that comes to about \$66 per pupil. The cost of raising the mean district's SELF PERCEPTION from 49.7 to 51.4--again a rise of one standard deviation--is only a 10.2 per cent rise in expenditures, or about \$50 per pupil. A comparable rise in DESIRE TO DO WELL, from 49.3 to 51.2, costs 26.6 per cent of expenditures, or about \$130 per pupil. The ability of schools to produce these outputs is clearly quite substantial, or these costs would be much higher. Of course, the production function estimates showed no input effects of this magnitude. Thus, these cost function estimates tend to further support the suspicion that the input variables in the production functions do not adequately represent the effects of schools.

Finally, these relative costs also indicate the trade-offs among outputs. The trade-off between COGNITIVE SCORE and SELF PERCEPTION, for example, is fairly even. A one per cent decrease in SELF PERCEPTION buys a little more than a one per cent increase in COGNITIVE SCORE. But since the variation in COGNITIVE SCORE is greater, one per cent changes are really not equivalent. A one standard deviation decrease in SELF PERCEPTION buys about three-fourths of a standard deviation in COGNITIVE SCORE. DESIRE TO DO WELL, on the other hand, is much more costly. It takes more than a two per cent decrease in either of the others to raise DESIRE TO DO WELL by one per cent. Clearly, a district that



considered DESIRE TO DO WELL to be a high priority would be at a relative disadvantage, and might end up with little in the way of other outputs.

Summary

1. Hypothesis one was that all the purchased inputs have positive effects on all the outputs. This hypothesis was not supported in the production function estimates; the production process is clearly much more complex. TEACH/PUP and AV EXPER have effects only on COGNITIVE SCORE. PCT MASTERS has both positive and negative effects. Quite unaccountably, NONTEACH/PUP has only negative effects. These rather spotty results, and the small size of even the significant coefficients suggest that the purchased input measures may not adequately represent the effects of schools.

2. Hypothesis two was that both experience and additional education are, in fact, purchased attributes. This hypothesis was supported in the regression of AV SAL on teacher attributes.

3. Hypothesis three was that a pay differential exists in favor of males, but that there is no difference in productivity. Both parts of this hypothesis were rejected; women are paid the same amount as men, but women are more productive. This result may reflect discrimination against women in employment alternatives, which results in relatively more qualified women becoming teachers.

4. The major hypotheses were that schools choose to produce different outputs, consistent with community preferences, and that it is this choice, not differential ability, that leads to the large

effects of background factors on individual outputs. In support of these general hypotheses, the specific predictions were for the following results.

a. Coefficients for SES and PCT WHITE were to be positive in single output production functions for COGNITIVE SCORE and DESIRE TO DO WELL, and negative in single output cost functions for these same outputs. SES showed the predicted effects in all cases but one, in which it was insignificant. PCT WHITE showed the predicted effects for COGNITIVE SCORE; it showed the opposite effects for DESIRE TO DO WELL except in one case, in which it was insignificant.

b. These same coefficients were to have the opposite signs from those above in the corresponding production and cost functions for SELF PERCEPTION and LIKING SCHOOL. PCT WHITE showed the predicted effects in production, but not cost functions; SES generally failed to support the prediction. The failure, especially of SES, to support this prediction weakens the argument that communities are simply choosing among outputs, and getting more of some at the cost of getting less of others.

c. These same coefficients were to be zero in multiple output production and cost functions. The effects disappeared from production functions in only two cases. SES retained its positive effect in two cases; PCT WHITE retained its positive effect in one, and its negative effect in two others. The effect of PCT WHITE did disappear from the cost function. Its effects in production functions notwithstanding, PCT WHITE does not effect the cost to communities of these outputs. Apparently, the opposing effects of PCT WHITE in

the production functions cancel out. The effect of SES, however, did not disappear from the cost function. Its negative effect in the cost function is consistent with its positive effects in the production functions. While its effect on cost is substantial, though, it could be offset with state aid of approximately the present magnitude.

d. Output coefficients were to be generally negative in production functions, and, in all cases, positive in the cost function. The production function coefficients were more positive than expected, but enough were negative to assure that districts do face trade-offs among outputs. LIKING SCHOOL showed a negative relationship to cost and had to be rejected as an output sought by schools at the margin. The other three outputs showed the proper relationship to cost. Furthermore, the cost function coefficients indicate a much stronger school effect than found in production function estimates, suggesting again that the school input measures are not really adequate.

TABLE 1.--Production Function Estimates: $\ln(\text{COGNITIVE SCORE})$ as the Dependent Variable.

	OLS	OLS	2SLS
$\ln(\text{CONSTANT})$	1.643896	1.257442	-.687628
$\ln(\text{DESIRE TO DO WELL})$		-.013715 (-.33)	.440270 ⁺⁺ (1.97)
$\ln(\text{SELF PERCEPTION})$		.064188 (1.32)	-.258190 (-1.01)
$\ln(\text{LIKING SCHOOL})$		.061323 (1.53)	.406949 (1.11)
$\ln(\text{TEACH/PUP})$	.026886 ⁺⁺ (1.82)	.026574 ⁺⁺ (1.80)	.025472 ⁺ (1.44)
$\ln(\text{NONTTEACH/PUP})$	-.000041 ^{**} (-2.89)	-.000038 ^{**} (-2.71)	-.000025 (-1.18)
$\ln(\text{AV EXPER})$	.043289 ⁺⁺ (7.73)	.042166 ⁺⁺ (7.50)	.041854 ⁺⁺ (5.35)
$\ln(\text{PCT MASTERS})$	.000037 ⁺⁺ (1.86)	.000035 ⁺⁺ (1.76)	.000066 ⁺⁺ (2.41)
$\ln(\text{PCT MALE})$	-.000157 ^{**} (-2.93)	-.000149 ^{**} (-2.78)	-.000120 [*] (-1.64)
$\ln(\text{PCT ELEM})$	-.007015 (-.60)	-.004367 (-.37)	-.012619 (-.80)
$\ln(\text{SIZE})$	-.004855 ^{**} (-2.51)	-.004912 ^{**} (-2.52)	-.006254 ^{**} (-2.39)
$\ln(\text{SES})$	.529391 ⁺⁺ (14.74)	.512414 ⁺⁺ (13.44)	.515578 ^{**} (6.43)
$\ln(\text{SES SD})$	-.002906 (-.20)	-.003312 (-.23)	.003860 (.21)
$\ln(\text{PCT WHITE})$	.061489 ⁺⁺ (6.22)	.063301 ⁺⁺ (6.26)	.084018 ^{**} (4.49)
R^2	.5291	.5332	[<.0005]

Coefficients represent elasticities; their t-values are in parentheses.

+ and ++ indicate significance at the .1 and .05 levels for a one-tailed test. * and ** indicate significance at the .1 and .05 levels for a two-tailed test. N = 519. The phi ratio significance level is in brackets.

TABLE 2.--Production Function Estimates: $\ln(\text{DESIRE TO DO WELL})$ as the Dependent Variable.

	OLS	OLS	2SLS
$\ln(\text{CONSTANT})$	3.494285	3.738929	5.502363
$\ln(\text{COGNITIVE SCORE})$		-.015813 (-.33)	.261823 ⁺ (1.33)
$\ln(\text{SELF PERCEPTION})$		.054233 (1.03)	.235023 (.81)
$\ln(\text{LIKING SCHOOL})$		-.098875 ⁺⁺ (-2.31)	-.812096 ⁺⁺ (-2.22)
$\ln(\text{TEACH/PUP})$	.002356 (.15)	.002896 (.18)	-.003151 (-.15)
$\ln(\text{NONTEACH/PUP})$	-.000015 (-1.01)	-.000018 (-1.20)	-.000026 (-1.10)
$\ln(\text{AV EXPER})$	-.005708 (-.95)	-.004027 (-.63)	-.007943 (-.64)
$\ln(\text{PCT MASTERS})$	-.000052 ^{**} (-2.45)	-.000053 ^{**} (-2.48)	-.000068 ^{**} (-2.37)
$\ln(\text{PCT MALE})$	-.000089 (-1.54)	-.000091 (-1.58)	-.000068 (-.79)
$\ln(\text{PCT ELEM})$	.017072 ⁺ (1.35)	.016321 ⁺ (1.29)	.009317 (.51)
$\ln(\text{SIZE})$	.005484 ^{**} (2.63)	.005184 ^{**} (2.47)	.005503 [*] (1.89)
$\ln(\text{SES})$	.126955 ⁺⁺ (3.29)	.127168 ⁺⁺ (2.68)	-.027519 (-.19)
$\ln(\text{SES SD})$	.004807 (.31)	.002752 (.18)	-.007239 (-.35)
$\ln(\text{PCT WHITE})$	-.042301 ^{**} (-3.97)	-.042426 ^{**} (-3.82)	-.071094 ^{**} (-3.58)
R^2	.1024	.1137	[.136]

Coefficients represent elasticities; their t-values are in parentheses. + and ++ indicate significance at the .1 and .05 levels for a one-tailed test. * and ** indicate significance at the .1 and .05 levels for a two-tailed test. N = 519. The phi ratio significance level is in brackets.

TABLE 3.--Production Function Estimates: $\ln(\text{SELF PERCEPTION})$ as the Dependent Variable.

	OLS	OLS	2SLS
$\ln(\text{CONSTANT})$	3.054136	2.746038	1.539194
$\ln(\text{COGNITIVE SCORE})$		.053160 (1.32)	-.126684 (-.86)
$\ln(\text{DESIRE TO DO WELL})$		.038955 (1.03)	.193912 (1.02)
$\ln(\text{LIKING SCHOOL})$		.021764 (.60)	.269032 (.90)
$\ln(\text{TEACH/PUP})$	.002790 (.21)	.001210 (.09)	.005014 (.34)
$\ln(\text{NONTTEACH/PUP})$	-.000011 (-.84)	-.000007 (-.56)	-.000005 (-.29)
$\ln(\text{AV EXPER})$	.004360 (.86)	.002010 (.37)	.007597 (.86)
$\ln(\text{PCT MASTERS})$	.000021 (1.14)	.000021 (1.14)	.000036 ⁺ (1.54)
$\ln(\text{PCT MALE})$	-.000087* (-1.79)	-.000074 (-1.50)	-.000076 (-1.26)
$\ln(\text{PCT ELEM})$	-.020612* (-1.93)	-.020518* (-1.92)	-.020029 (-1.62)
$\ln(\text{SIZE})$	.002763 (1.57)	.002824 (1.58)	.001284 (.55)
$\ln(\text{SES})$	.243068** (7.45)	.208874** (5.31)	.271847** (3.28)
$\ln(\text{SES SD})$	.017559 (1.33)	.017758 (1.34)	.019134 (1.32)
$\ln(\text{PCT WHITE})$	-.017490 ⁺⁺ (-1.95)	-.018660 ⁺⁺ (-1.96)	.004070 (.21)
R^2	.1631	.1682	[.008]

Coefficients represent elasticities; their t-values are in parentheses. ⁺ and ⁺⁺ indicate significance at the .1 and .05 levels for a one-tailed test. * and ** indicate significance at the .1 and .05 levels for a two-tailed test. N = 519. The phi ratio significance level is in brackets.

TABLE 4.--Production Function Estimates: $\ln(\text{LIKING SCHOOL})$ as the Dependent Variable.

	OLS	OLS	2SLS
$\ln(\text{CONSTANT})$	3.886583	4.032282	4.467704
$\ln(\text{COGNITIVE SCORE})$		.075351 (1.53)	.097393 (.57)
$\ln(\text{DESIRE TO DO WELL})$		-.105369 ⁺⁺ (-2.31)	-.326819 ⁺⁺ (-1.69)
$\ln(\text{SELF PERCEPTION})$		.032291 (.60)	.131223 (.54)
$\ln(\text{TEACH/PUP})$	.002694 (.16)	.000826 (.05)	.000479 (.03)
$\ln(\text{NONTEACH/PUP})$	-.000029* (-1.86)	-.000027* (-1.74)	-.000029 (-1.63)
$\ln(\text{AV EXPER})$	.012466 ⁺⁺ (2.00)	.008462 ⁺ (1.29)	.005812 (.57)
$\ln(\text{PCT MASTERS})$	-.000002 (-.09)	-.000011 (-.50)	-.000025 (-.94)
$\ln(\text{PCT MALE})$	-.000050 (-.84)	-.000045 (-.75)	-.000052 (-.74)
$\ln(\text{PCT ELEM})$	-.017775 (-1.36)	-.014782 (-1.13)	-.008808 (-.59)
$\ln(\text{SIZE})$	-.000742 (-.34)	.000112 (.05)	.001160 (.43)
$\ln(\text{SES})$	.050805 (1.27)	.016443 (.33)	.008842 (.07)
$\ln(\text{SES SD})$	-.010689 (-.66)	-.010530 (-.65)	-.011139 (-.65)
$\ln(\text{PCT WHITE})$	-.020692 ⁺⁺ (-1.88)	-.029218 ⁺⁺ (-2.53)	-.038211 ^{**} (-2.05)
R^2	.0363	.0517	[.550]

Coefficients represent elasticities; their t-values are in parentheses. + and ++ indicate significance at the .1 and .05 levels for a one-tailed test. * and ** indicate significance at the .1 and .05 levels for a two-tailed test. N = 519. The phi ratio significance level is in brackets.

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TABLE 5.--Cost Function Estimates: $\ln(\text{INSTR})$ as the Dependent Variable.

	1	2	3	4	5
$\ln(\text{CONSTANT})$	-3.938645	-25.433859	-7.766367	7.136692	-29.205934
$\ln(\text{COG SCORE})$	2.917362 ⁺⁺ (5.59)				2.696233 ⁺⁺ (2.34)
$\ln(\text{DESIRE...})$		7.863875 ⁺⁺ (5.45)			7.002061 ⁺⁺ (4.32)
$\ln(\text{SLF PERCEP})$			3.186247 ⁺⁺ (3.11)		3.012350 ⁺ (1.43)
$\ln(\text{LIKING SCH})$				-1.302347 (-1.23)	-1.867227 (-.66)
$\ln(\text{SIZE})$	.068746 ^{**} (7.22)	.016194 (.94)	.041255 ^{**} (4.65)	.045004 ^{**} (5.68)	.030707 (1.53)
$\ln(\text{SES})$	-.704845 ⁺⁺ (-2.21)	-.158318 (-.44)	.021034 (.07)	.874582 ⁺⁺ (5.50)	-2.092896 ^{**} (-2.55)
$\ln(\text{SES SD})$	.052300 (.75)	-.007192 (-.06)	-.035780 (-.51)	-.014074 (-.22)	-.031251 (-.22)
$\ln(\text{PCT WHITE})$	-.393458 ⁺⁺ (-7.26)	.103938 (.97)	-.176824 ^{**} (-3.51)	-.268834 ^{**} (-5.60)	-.062005 (-.36)
$\ln(\text{SAL})$	.279330 ⁺⁺ (3.74)	.110498 (.79)	.217501 ⁺⁺ (2.97)	.178520 ⁺⁺ (2.55)	.146263 (.95)
Phi ratio signif. level	[<.0005]	[.116]	[<.0005]	[<.0005]	[.442]

Coefficients represent elasticities; their t-values are in parentheses.
⁺ and ⁺⁺ indicate significance at the .1 and .05 levels for a one-tailed test. * and ** indicate significance at the .1 and .05 levels for a two-tailed test. N = 519. 2SLS instruments were used for all outputs.

CHAPTER VI

AN EXTENSION USING INTERACTION TERMS

Production Function Estimates with Interaction Terms

The preceding chapter found some evidence for the idea that background effects work through the choices made by different district types. It showed that only SES had a significant impact on the options open to districts, as represented in the cost function. However, the evidence did not support the hypothesis that background effects operate solely through choice. At least one background factor remained significant in each production function.

These results, of course, all assume a particular form of the production function. Specifically, the background factors were assumed to have effects, separable from the effects of schools. They were allowed only to shift up and down the production functions for schools. Some researchers have argued, though, that children from different backgrounds will react differently to the same school inputs.¹ Such an argument implies that the school input coefficients will themselves be different for different community types. This hypothesis is worth testing, especially in view of the preceding results, that background effects cannot be explained solely through choice.

¹For example, see: Eric Hanushek, "Teacher Characteristics and Gains in Student Achievement: Estimation Using Micro Data," American Economic Review, 61 (May, 1971), pp. 280-288; Michelson, op. cit.

The production functions will be modified so that each school input elasticity includes what amounts to a slope coefficient for each of the background factors. The background factors will be retained in separate intercept terms as well. The production function for COGNITIVE SCORE, for example, becomes:

$$\begin{aligned}
 \text{COG SCORE}_i = & a_0 \cdot [\text{DESIRE} \dots]_i^{a_1} \cdot \text{SLF PERCEP}_i^{a_2} \cdot \text{LIKING SCH}_i^{a_3} \\
 & \cdot [\text{TEACH/PUP}_i^{(b_{10} + b_{11}\text{SIZE}_i + b_{12}\text{SES}_i + b_{13}\text{SES SD}_i + b_{14}\text{PCT WHITE}_i)} \\
 & \cdot \text{NONT EACH/PUP}_i^{(b_{20} + b_{21}\text{SIZE}_i + b_{22}\text{SES}_i + b_{23}\text{SES SD}_i + b_{24}\text{PCT WHITE}_i)} \\
 & \cdot \dots \\
 & \cdot \text{PCT ELEM}_i^{(b_{60} + b_{61}\text{SIZE}_i + b_{62}\text{SES}_i + b_{63}\text{SES SD}_i + b_{64}\text{PCT WHITE}_i)} \\
 & \cdot [\text{SIZE}_i^{d_1} \cdot \text{SES}_i^{d_2} \cdot \text{SES SD}_i^{d_3} \cdot \text{PCT WHITE}_i^{d_4}] \cdot e^{u_i}
 \end{aligned} \tag{6.1}$$

If only the intercept terms in the school input elasticities (b_{10} , b_{20} , $\dots$, b_{60}) are different from zero, this production function reduces to the previous one. If some of the slope coefficients are nonzero, though, the school input effects will, themselves, depend on the type of district. Taking logs and simplifying, the equation to be estimated by 2SLS is:

$$\begin{aligned}
 \ln(\text{COG SCORE}_i) = & \ln(a_0) + [a_1 \ln(\text{DESIRE} \dots)_i + a_2 \ln(\text{SLF PERCEP}_i) + a_3 \ln(\text{LIKING SCH}_i)] \\
 & + [b_{10} \ln(\text{TEACH/PUP}_i) + b_{11} \text{SIZE}_i \ln(\text{TEACH/PUP}_i) \\
 & \quad + \dots + b_{14} \text{PCT WHITE}_i \ln(\text{TEACH/PUP}_i)
 \end{aligned}$$

$$\begin{aligned}
& + b_{20} \ln(\text{NONTCH/PUP}_i) + b_{21} \text{SIZE}_i \ln(\text{NONTCH/PUP}_i) \\
& \quad + \dots + b_{24} \text{PCT WHITE}_i \ln(\text{NONTCH/PUP}_i) \\
& \quad \cdot \\
& \quad \cdot \\
& \quad \cdot \\
& + b_{60} \ln(\text{PCT ELEM}_i) + b_{61} \text{SIZE}_i \ln(\text{PCT ELEM}_i) \\
& \quad + \dots + b_{64} \text{PCT WHITE}_i \ln(\text{PCT ELEM}_i) \\
& + [d_1 \ln(\text{SIZE}_i) + d_2 \ln(\text{SES}_i) + d_3 \ln(\text{SES SD}_i) \\
& \quad + d_4 \ln(\text{PCT WHITE}_i)] + u_i.
\end{aligned} \tag{6.2}$$

The interaction terms, each consisting of a background variable multiplied by the log of a school input variable, were calculated for each district. Their coefficients represent the slope coefficients in the school input elasticities. If significant, these interaction coefficients support the hypothesis that school inputs have different effects in different types of districts.

The results are reported in Tables 6-9. The first columns repeat the previous estimates, without interactions, for purposes of comparison. Columns two through six present the new estimates, with columns three through six giving the interaction coefficients. In the production function for COGNITIVE SCORE, for example, the coefficient for $\text{SES} \ln(\text{NONTCH/PUP})$ is .000017. It is an estimate that any rise of one point in SES would raise the NONTCH/PUP elasticity in the production of COGNITIVE SCORE by .000017. While the product of the interaction coefficient and the background measure is invariant to scale, the coefficient by itself is not. To avoid scaling problems,

SIZE is divided by 1000 for all interactions, making its interaction coefficients 1000 times as large as they would otherwise have been. The size and variation of these background measures must be kept in mind when assessing the impact of the interactions.

The inclusion of interactions requires a couple of changes in the interpretation of the ordinary input coefficients. First, the previous hypotheses about total input effects do not translate into hypotheses about ordinary input and interaction coefficients. Thus, two-tailed tests of significance are now necessary for all input related coefficients--even those for which one-tailed tests were appropriate before. Secondly, the economic meaning of the ordinary input coefficients is considerably diminished. The previous coefficients represented the total input elasticities for all districts; the new coefficients represent extrapolations of these input elasticities, for a district with zero students, zero SES, etc. One must specify meaningful background characteristics before one can calculate meaningful total input elasticities, and the elasticities obtained will depend on the characteristics chosen.

Obviously, some very important changes take place with the addition of these interaction terms. Consider, first, the production function for COGNITIVE SCORE. The three highly significant background effect terms all become smaller, and only PCT WHITE remains significant at the .10 level. These factors seem to have their effects, instead, through their interactions with school inputs. Both SIZE and PCT WHITE have positive effects on the productivity of NONTEACH/PUP, and negative effects on the productivity of PCT MASTERS. SES has positive effects

on the productivities of both NONTEACH/PUP and PCT MALE. Apparently it was these effects that caused the background terms to be significant in the absence of interaction terms. The effect on SES SD is quite different. Though still not quite significant, its effect becomes very much stronger. Several of its interaction terms also approach significance. Some of these effects must have tended to cancel out in the previous estimates.

Looking to the effects of inputs, both TEACH/PUP and AV EXPER lose their significance with the introduction of interaction terms. Since TEACH/PUP was previously only marginally significant (for a one-tailed test), its loss of significance is not entirely unexpected. But AV EXPER was previously the most significant input, so its loss of significance is more surprising. Especially in this latter case, the loss of significance probably results from spreading the total input effect so evenly over a number of variables that no one of them is significant. One suspects that an F-statistic would show that the total AV EXPER effect, of the ordinary input coefficient plus the four interaction coefficients, is still significant. Unfortunately, though, F-statistics are not available because of the way 2SLS estimates are calculated.

Perhaps the most striking change among the input effects occurs for NONTEACH/PUP. Four of its five coefficients are now significant. Taken together, they indicate a strong negative effect for small, low SES and black districts. For a district with mean background characteristics, though, the effect becomes positive (.000058), and for large, high SES and white districts, the positive

effect is substantial. Nonteaching professionals are staff specialists of various sorts. The more students in a district, the more possibilities exist for staff specialization. Thus, NONTEACH/PUP is one school input with potential for economies with increased district size. The strong positive interaction with SIZE suggests that such economies are, in fact, realized.

The positive interactions with SES and PCT WHITE can be explained in two general ways. The first explanation, suggested originally, is that children from different backgrounds are reacting differently to the same input. What is a productive input for high SES, white children is actually counterproductive for low SES, black children. These different reactions could result from the training of such specialists, or from the backgrounds which these specialists, themselves, represent. That is, if these nonteaching professionals are overwhelmingly high SES whites, it would not be at all surprising for them to be more productive with children of similar backgrounds.

A second explanation of these interactions must be considered too. Perhaps the nonteaching professionals in different types of districts are not really comparable. This possibility seems especially important for NONTEACH/PUP, since nonteaching professionals can include such a wide variety of personnel. Differences in the input, rather than differences in the children, could cause these interactions. The differences in the input could be caused, in turn, by differences in the output preferences of communities. Indeed, these interactions are consistent with the output preferences hypothesized in the preceding chapters. That is, high SES and white districts tend to

hire more of the nonteaching professionals oriented toward promoting COGNITIVE SCORE, and fewer of the nonteaching professionals oriented toward the other outputs.

The first explanation, then, would attribute these interactions to differences in production relationships. The second would attribute them, instead, to unmeasured differences in the input for different community types, stemming, systematically, from their different educational goals. The ambiguity is especially acute because these interactions show the signs consistent with hypothesized output preferences. Such consistency is not the rule in all cases, though. PCT MASTERS shows negative interactions with both SIZE and PCT WHITE. That is, while PCT MASTERS is a productive input for small, black districts, it quickly becomes counterproductive as the size and percentage of whites increase. The SIZE interaction suggests that, while having some master's degree holders is useful in producing COGNITIVE SCORE, maintaining a particular percentage as the district gets larger is not. The PCT WHITE interaction, however, suggests either that blacks and whites respond differently to master's degree holders, or that important unmeasured differences exist between the master's degree holders in the two types of districts. In this case, though, the interaction's negative sign is inconsistent with hypothesized output preferences. White districts were hypothesized to put relatively more emphasis on COGNITIVE SCORE. Thus, if the interaction were indicating that white districts hire master's degree holders who are more COGNITIVE SCORE oriented, in some manner, the sign of the interaction would have been positive. In this case, then,

the more persuasive argument may be that a real production function difference exists. Apparently, the training involved in the master's degree is more worthwhile to teachers in their dealings with black, than with white children, at least in terms of increasing COGNITIVE SCORE.

The final interaction in the COGNITIVE SCORE production function is that of PCT MALE with SES. Males can have negative effects relative to females, for low SES districts. For high SES districts, though, they have strong positive effects relative to females. Either low and high SES children react very differently to male, as opposed to female teachers, or there are some very important unmeasured differences in the qualities of the males relative to the females, between the low and high SES districts. The output preferences of low and high SES districts are no help in this case since neither PCT MALE, nor its complement, PCT FEMALE, is a purchased input. Certainly, high SES districts are endeavoring to hire male teachers who support the districts' goals, but they are looking for this same quality in their female teachers. Thus, the greater relative effectiveness of males in high, rather than low SES districts may also reflect a real production function difference, based, perhaps, on different sex role stereotypes prevalent in the different district types.

Turning to the production function for DESIRE TO DO WELL, the effects of adding interactions are, in some respects, quite similar to those which were observed for COGNITIVE SCORE. The previously important background coefficients become insignificant. The effects of SIZE again occur through its interactions with NONTEACH/PUP and

PCT MASTERS, though their signs are reversed from the former case. SES has an interaction effect with AV EXPER; the effects of PCT WHITE disappear entirely. The effect of SES SD again becomes much larger, this time becoming significant by itself and through four of its interactions. Apparently, heterogeneity increases the DESIRE TO DO WELL of a district, both directly and, indirectly, by raising the productivity of its school inputs.

The effects of inputs are best treated in groups. The elasticities of TEACH/PUP, NONTEACH/PUP, PCT MALE and PCT ELEM all depend on SES SD, and vary from negative for at least some homogeneous districts, to strongly positive for other, highly heterogeneous ones. These interactions almost certainly represent real production function differences. There have been no hypotheses that the heterogeneity of a district should affect its output preferences. Thus, there is no reason to expect systematic unmeasured differences in these inputs on the basis of heterogeneity. For some reason, school inputs in heterogeneous districts are just more productive of DESIRE TO DO WELL.

NONTEACH/PUP and PCT MASTERS also show interactions with SIZE. These same two inputs showed SIZE interactions in the production function for COGNITIVE SCORE, but in the opposite directions. NONTEACH/PUP was described as being made up of a variety of specialists, suggesting the potential for greater efficiency as the districts got larger. That view was supported for COGNITIVE SCORE; it is not supported for DESIRE TO DO WELL. The greater efficiency of the larger districts' nonteaching professionals in producing COGNITIVE SCORE is offset by their lower efficiency in producing DESIRE TO DO WELL. The

interaction for PCT MASTERS switches in the opposite direction. Whereas master's degree holders in the larger districts were less productive of COGNITIVE SCORE, they are more productive of DESIRE TO DO WELL. Presumably these interactions with SIZE all represent real production function effects. Since the signs change in opposite directions, these effects are unlikely to reflect output preferences, with large districts emphasizing one of the outputs more at the expense of the other. There have been no hypotheses that the district's size should affect its output preferences in any case. Little can be said, though, as to why such production function effects should be expected.

The final interaction in the DESIRE TO DO WELL production function is that of AV EXPER with SES. Happily, this interaction seems more plausible than some of the preceding ones. High SES districts were hypothesized to emphasize this output, as well as COGNITIVE SCORE. They may simply hire teachers whose experience is oriented, in some manner, relatively more toward this output. Thus, this interaction may result from the output preferences of high and low SES districts. It could also represent real production function differences. More experienced teachers will tend to be older, and will tend to employ teaching techniques based on what has worked for them in the past. These attributes could conceivably be more productive with high, than with low SES children.

Less need be said about the other two production function estimates. In the production function for SELF PERCEPTION, SES, the only background factor to be significant previously, loses its

significance with the introduction of interactions. In addition, only two interactions are significant--those of NONTEACH/PUP and PCT MASTERS with SIZE. These are the same SIZE interactions that were observed in the production functions for both COGNITIVE SCORE and DESIRE TO DO WELL; their signs are the same as they were in the COGNITIVE SCORE case. Nothing more can be added in this case to what has already been said in the discussions of these other cases. The production function for LIKING SCHOOL is included, too, for completeness, but since this attitude has been eliminated as an output sought by schools, it warrants no detailed examination.

Clearly, many of the individual interactions are hard to interpret. Taking the estimates as a whole, though, some important general results stand out. First of all, the school input effects are much more complicated than originally assumed. Not only do school input effects vary among outputs, they even vary for given outputs, among districts with different background characteristics. While some of the SES and PCT WHITE interactions could really be reflecting unmeasured differences in the inputs based on different output preferences, most of the interactions probably reflect these real differences in the production relationships among districts. Inputs such as NONTEACH/PUP and PCT MALE no longer show uniformly negative effects. For some outputs in some types of districts, these inputs can be quite productive. Conversely, those inputs that seemed most productive before (such as AV EXPER for COGNITIVE SCORE), are actually productive for only some districts.

Secondly, the background factors are much less important, on their own, than they were in previous estimates. SES SD is significant in one production function; PCT WHITE is barely significant in another. The background coefficients that remained significant in the previous multiple output production functions, did so not because of separable background effects, but because the effects of specific school inputs depend on the students' backgrounds. These interactions probably have more to do with how a particular type of district should produce its outputs, though, than with how much it will be able to produce.

Cost Function Estimates with Interaction Terms

The impact of interactions on the production function estimates raises the question of whether such terms might have similar effects on the cost function estimate. The output exponents in the cost function can be expanded in the same manner as the school input coefficients were in the production functions. Taking logs gives an ordinary coefficient and interactions for each output. The interaction terms, if significant, indicate that different district types face different trade-offs among outputs.

The first problem is underidentification. Since the outputs are endogenous, their interactions are too. There are not this many excluded exogenous variables, though, so the interactions must be entered in small groups. This procedure was followed, using 2SLS instruments for the outputs, plus four interactions at a time. The results, though, are clearly meaningless (see Appendix, Table A9); apparently interactions do not belong in the cost function.

TABLE 6.--Production Function Estimate Using Interaction Terms: $\ln(\text{COGNITIVE SCORE})$ as the Dependent Variable.

	Without	With	Interactions			
$\ln(\text{CONSTANT})$	-.687628	3.558068				
$\ln(\text{DESIRE...})$	.440270 ^{††} (1.97)	.217606 (.95)				
$\ln(\text{SLF PERCEP})$	-.258190 (-1.01)	-.351037 [†] (-1.49)				
$\ln(\text{LIKING SCH})$	.406949 (1.11)	.277779 (.99)	SIZE/1000	SES	SES SD	PCT WHITE
$\ln(\text{TEACH/PUP})$	.025472 [†] (1.44)	.366363 (.98)	-.002054 (-.69)	-.002117 (-.37)	-.019484 (-1.36)	-.000700 (-.38)
$\ln(\text{NONTCH/PUP})$	-.000025 (-1.18)	-.001752 ^{**} (-2.63)	.000032 ^{**} (2.59)	.000017 [*] (1.76)	-.000024 (-1.29)	.000011 ^{**} (2.27)
$\ln(\text{AV EXPER})$	.041854 ^{††} (5.35)	.180218 (1.04)	-.001511 (-.99)	-.000685 (-.21)	-.010116 (-1.27)	-.000060 (-.07)
$\ln(\text{PCT MASTER})$	.000066 ^{††} (2.41)	.003851 ^{**} (2.28)	-.000313 [*] (-1.94)	.000017 (.56)	.000036 (1.08)	-.000049 ^{**} (-2.12)
$\ln(\text{PCT MALE})$	-.000120 [*] (-1.64)	-.219555 [*] (-1.70)	-.000001 (-.00)	.006020 [*] (1.92)	-.007068 (-1.49)	-.000134 (-.13)
$\ln(\text{PCT ELEM})$	-.012619 (-.80)	.177102 (.57)	-.000531 (-.27)	-.004081 (-.82)	.003916 (.33)	-.000287 (-.17)
$\ln(\text{SIZE})$	-.006254 ^{**} (-2.39)	-.003642 (-.95)				
$\ln(\text{SES})$	.515578 ^{**} (6.43)	.023564 (.03)				
$\ln(\text{SES SD})$	.003860 (.21)	-.240938 (-1.46)				
$\ln(\text{PCT WHITE})$	.084018 ^{**} (4.49)	.061280 [*] (1.67)				
Phi ratio						
signif. level	[<.0005]	[<.0005]				

The t-values are in parentheses.

† and †† indicate significance at the .1 and .05 levels for a one-tailed test.

* and ** indicate significance at the .1 and .05 levels for a two-tailed test.

N = 519. 2SLS instruments were used for all outputs.

TABLE 7.--Production Function Estimate Using Interaction Terms: $\ln(\text{DESIRE TO DO WELL})$ as the Dependent Variable.

	Without	With	Interactions			
$\ln(\text{CONSTANT})$	5.502363	2.168019				
$\ln(\text{COG SCORE})$	.261823 [†] (1.33)	.118737 (.69)				
$\ln(\text{SLF PERCEP})$	.235023 (.81)	.269288 (1.13)				
$\ln(\text{LIKING SCH})$	-.812096 ^{††} (-2.22)	-.430331 [†] (-1.58)	SIZE/1000	SES	SES SD	PCT WHITE
$\ln(\text{TEACH/PUP})$	-.003151 (-.15)	-.773327 ^{**} (-2.28)	-.002584 (-.86)	.007437 (1.33)	.041239 ^{**} (3.63)	.000620 (.33)
$\ln(\text{NONTCH/PUP})$	-.000026 (-1.10)	-.000046 (-.06)	-.000025 ^{**} (-1.96)	.000003 (.28)	.000061 ^{**} (4.54)	-.000006 (-1.23)
$\ln(\text{AV EXPER})$	-.007943 (-.64)	-.118369 (-.67)	-.001195 (-.77)	.005088* (1.64)	-.004212 (-.51)	-.001088 (-1.39)
$\ln(\text{PCT MASTER})$	-.000068 ^{**} (-2.37)	-.000549 (-.30)	.000320 ^{**} (2.06)	-.000008 (-.26)	-.000044 (-1.32)	.000012 (.47)
$\ln(\text{PCT MALE})$	-.000068 (-.79)	-.225096* (-1.79)	-.002910 (-1.13)	.003531 (1.08)	.008596* (1.88)	.000098 (.09)
$\ln(\text{PCT ELEM})$	.009317 (.51)	-.171398 (-.54)	.000849 (.43)	-.001207 (-.24)	.019598* (1.77)	.000703 (.41)
$\ln(\text{SIZE})$	.005503* (1.89)	.005972 (1.61)				
$\ln(\text{SES})$	-.027519 (-.19)	.267634 (.34)				
$\ln(\text{SES SD})$	-.007239 (-.35)	.304854* (1.94)				
$\ln(\text{PCT WHITE})$	-.071094 ^{**} (-3.58)	.012666 (.33)				
Phi ratio signif. level	[.136]	[.036]				

The t-values are in parentheses.

† and †† indicate significance at the .1 and .05 levels for a one-tailed test.

* and ** indicate significance at the .1 and .05 levels for a two-tailed test.

N = 519. 2SLS instruments were used for all outputs.

TABLE 8.--Production Function Estimate Using Interaction Terms: ln(SELF PERCEPTION) as the Dependent Variable.

	Without	With	Interactions			
ln(CONSTANT)	1.539194	4.883983				
ln(COG SCORE)	-.126684 (-.86)	-.176166 (-1.19)				
ln(DESIRE...)	.193912 (1.02)	.247667 (1.24)				
ln(LIKING SCH)	.269032 (.90)	.172885 (.69)	SIZE/1000	SES	SES SD	PCT WHITE
ln(TEACH/PUP)	.005014 (.34)	.037778 (.11)	-.000220 (-.08)	-.001946 (-.38)	-.005517 (-.42)	.001096 (.68)
ln(NONTCH/PUP)	-.000005 (-.29)	-.000620 (-.98)	.000021* (1.88)	.000007 (.78)	-.000023 (-1.40)	.000005 (1.03)
ln(AV EXPER)	.007597 (.86)	.137692 (.90)	.000022 (.02)	-.003494 (-1.25)	-.002683 (-.37)	.000784 (1.13)
ln(PCT MASTER)	.000036† (1.54)	.000810 (.51)	-.000400** (-3.25)	-.000001 (-.04)	.000038 (1.31)	-.000009 (-.42)
ln(PCT MALE)	-.000076 (-1.26)	-.040545 (-.34)	.000063 (.27)	.001465 (.50)	-.004842 (-1.15)	.000041 (.04)
ln(PCT ELEM)	-.020029 (-1.62)	-.241827 (-.88)	-.000426 (-.25)	.003106 (.71)	.003767 (.36)	.000301 (.20)
ln(SIZE)	.001284 (.55)	.000706 (.20)				
ln(SES)	.271847** (3.28)	-.479689 (-.71)				
ln(SES SD)	.019134 (1.32)	-.061040 (-.41)				
ln(PCT WHITE)	.004070 (.21)	.032833 (.99)				
Phi ratio signif. level	[.008]	[.009]				

The t-values are in parentheses.

† and †† indicate significance at the .1 and .05 levels for a one-tailed test.

* and ** indicate significance at the .1 and .05 levels for a two-tailed test.

N = 519. 2SLS instruments were used for all outputs.



TABLE 9.--Production Function Estimate Using Interaction Terms: $\ln(\text{LIKING SCHOOL})$ as the Dependent Variable.

	Without	With	Interactions			
$\ln(\text{CONSTANT})$	4.467704	4.883134				
$\ln(\text{COG SCORE})$	.097393 (.57)	.101172 (.57)				
$\ln(\text{DESIRE...})$	-.326819 ⁺⁺ (-1.69)	-.287241 (-1.27)				
$\ln(\text{SLF PERCEP})$	.131223 (.54)	.125473 (.50)	SIZE/1000	SES	SES SD	PCT WHITE
$\ln(\text{TEACH/PUP})$	.000479 (.03)	-.106657 (-.27)	-.000107 (-.03)	-.000065 (-.01)	.014697 (1.00)	-.000139 (-.07)
$\ln(\text{NONTCH/PUP})$	-.000029 (-1.63)	-.000615 (-.83)	-.000002 (-.13)	-.000001 (-.05)	.000044 ^{**} (2.82)	.000003 (.48)
$\ln(\text{AV EXPER})$	.005812 (.57)	-.195346 (-1.12)	-.000214 (-.13)	.002797 (.85)	.011275 (1.44)	-.000406 (-.49)
$\ln(\text{PCT MASTER})$	-.000025 (-.94)	-.000812 (-.43)	.000035 (.20)	-.000056 ^{**} (-2.06)	-.000067 ^{**} (-2.25)	.000042 [*] (1.88)
$\ln(\text{PCT MALE})$	-.000052 (-.74)	-.101905 (-.75)	.000105 (.04)	.000326 (.09)	-.000479 (-.09)	.000987 (.94)
$\ln(\text{PCT ELEM})$	-.008808 (-.59)	.097869 (.30)	-.000090 (-.04)	-.000275 (-.05)	.000039 (.00)	-.000978 (-.57)
$\ln(\text{SIZE})$	.001160 (.43)	-.000399 (-.10)				
$\ln(\text{SES})$	.008842 (.07)	-.298800 (-.37)				
$\ln(\text{SES SD})$	-.011139 (-.65)	.211897 (1.28)				
$\ln(\text{PCT WHITE})$	-.038211 ^{**} (-2.05)	.000131 (.00)				
Phi ratio signif. level	[.550]	[.249]				

The t-values are in parentheses.

† and †† indicate significance at the .1 and .05 levels for a one-tailed test.

* and ** indicate significance at the .1 and .05 levels for a two-tailed test.

N = 519. 2SLS instruments were used for all outputs.

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CHAPTER VII

SUMMARY AND CONCLUSION

Public education has traditionally held an important place in American egalitarian philosophy, as a guarantor of social mobility. To be effective in such a role, though, schools must be able to produce this education, and indeed, to do so well enough to overcome the disadvantages of lower class and black children. Thus, the implication of the Coleman report, that public schools are not effective enough to overcome the effects of class and race, is most disturbing. Because of the seriousness of this implication, much additional work has been undertaken to confirm or deny Coleman's results. To date, the weight of the evidence supports his findings.

This study has taken the position that such results are based on inadequate models of schools. Most studies have assumed that school output can be represented by a measure of cognitive achievement. Noncognitive outputs are either unimportant, or produced in fixed proportions with the cognitive output. All community types require the same output of their schools; some just succeed more than others. Rejecting such a view of schools, this study has developed a multiple output model of education. This model not only acknowledges a wide spectrum of school outputs, not necessarily produced in fixed proportions with cognitive achievement, but explicitly predicts that different district types will choose to emphasize different outputs.

Thus, for a given level of school inputs or expenditures, certain district types will excel in the production of particular outputs by choosing to sacrifice their other outputs.

The empirical work by Downey¹ gives a basis for predicting which types of districts will emphasize particular outputs. His findings indicate that upper class, white communities will put the greater emphasis on cognitive achievement, and other "intellectual" outputs. Other community types will tend to emphasize other outputs relatively more. Such results suggest a reason for the powerful background effects, found in past studies, which has nothing to do with the true effectiveness of schools. Since these studies have measured only the cognitive output, that upper class, white districts emphasize most, the upper class, white districts certainly should appear to be more effective, even if all districts are, in fact, equally able to produce all educational outputs.

The major hypotheses of this study, then, have been that schools choose to produce different outputs, consistent with community preferences, and that it is this choice, not differential ability, that leads to the large effects of background factors on individual outputs. The study has used data of the Michigan Educational Assessment Program to test these hypotheses with a set of production and cost relationships. In addition to "cognitive score," hypothesized output measures included "desire to do well," "self perception" and "liking school." The first two were predicted to represent "intellectual"

¹Downey, op. cit.

outputs, emphasized more by upper class and white districts; the latter two were predicted to be emphasized relatively more by lower class and black districts.

Production function estimates should show positive relationships between purchased inputs and outputs sought by schools. This requirement was generally satisfied for "cognitive score"; it was generally not satisfied for the attitude outputs. Because of doubts about the adequacy of the input data, though, these hypothesized outputs were not rejected on this basis. Cost function estimates should show positive relationships between expenditures and outputs sought by schools. This requirement was satisfied for all outputs except "liking school," which was therefore rejected as an output sought by schools.

In support of the major hypotheses, a positive relationship was predicted between "intellectual" outputs and community background factors of socioeconomic status and per cent white in production and cost functions which improperly include only these outputs (as in past studies). On the other hand, since choosing relatively more of the "intellectual" implies choosing relatively less of the others, a negative relationship was predicted between the other outputs and these same background factors in production and cost functions which improperly include only these outputs. Finally, these same background effects were predicted to become insignificant in production and cost functions properly including all outputs.

These predictions were partially supported for the per cent white. This background measure had a positive effect only in the

production function for "cognitive score"; in two other production functions, its effect was negative. But only in one case did this effect drop out with the inclusion of the other outputs. A positive and a negative effect remained. The cost function indicated that these two effects tend to cancel out; neither district type showed a cost advantage with all outputs included. Yet the evidence remains that differences in the production relationships do exist.

The predictions were rejected for socioeconomic status. This measure had a positive effect in three production functions; it had no countervailing, negative effects. In only one case did the effect drop out with the inclusion of the other outputs. And its effect remained significant in the multiple output cost function. For a given expenditure level, higher socioeconomic status districts can produce more of all outputs.

Because at least one background effect remained significant in every production function, an extension was attempted, to define these effects more precisely through the use of interactions. The results were often difficult to interpret. It was the interactions, though, rather than the pure background variables, that tended to be significant. Backgrounds are important, then, not because of very general differences in the abilities of different groups of children, but because of very specific differences in their reactions to particular inputs.

This study suggests certain areas in which further research is essential. For example, the implicit assumption of past studies, that noncognitive outputs are produced in fixed proportions with

cognitive achievement and can be ignored, is certainly refuted. Yet the production function estimates for noncognitive outputs do little more than express the present ignorance. Hopefully, the model developed for this study will guide future research in this area. Educators have been too willing to talk of general "effectiveness." They will need to talk of effectiveness in the production of specific outputs. They will need to identify the input differences between schools which emphasize cognitive achievement and those which emphasize self perception, or something else.

Likewise, the significance of interactions indicates the need to better understand how characteristics of a student's background affect his reactions to specific inputs. Perhaps with improved understanding, even the disadvantages of low socioeconomic status may be largely mitigated. Without an understanding of these interactions, attempts to use high socioeconomic status schools as models for improving lower socioeconomic status schools may actually be counter-productive.

Finally, a more general result of this study is the reassertion of the normative aspects of education, and of its evaluation. With only one output, schools can be evaluated entirely on technical grounds. A better school is just a more efficient one. The simplicity of this view accounts for its appeal. But it is an extremely unrealistic view of the role that education plays in a complex society. Once multiple outputs are recognized, of course, the definition of a good school is much less clear. Technical efficiency is still a

valid concern. But two schools can both be technically efficient, and still have very different outputs. In the final analysis, the choice among outputs is essentially a value judgment.

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APPENDIX

TABLE A1.--Production Function Estimate: $\ln(\text{COGNITIVE SCORE})$ as the Dependent Variable. The Effects of Using 2SLS Instruments for all but Background Factors (2).

$\ln(\text{CONSTANT})$	-.687628	-.369874
$\ln(\text{DESIRE TO DO WELL})$	.440270 ⁺⁺ (1.97)	1.450260 (1.16)
$\ln(\text{SELF PERCEPTION})$	-.258190 (-1.01)	-1.647285 ⁺ (-1.28)
$\ln(\text{LIKING SCHOOL})$	.406949 (1.11)	.092990 (.07)
$\ln(\text{TEACH/PUP})$	.025472 ⁺ (1.44)	-.197698 (-.68)
$\ln(\text{NONTEACH/PUP})$	-.000025 (-1.18)	-.000498 (-.90)
$\ln(\text{AV EXPER})$	.041854 ⁺⁺ (5.35)	.097910 ⁺ (1.42)
$\ln(\text{PCT MASTERS})$	.000066 ⁺⁺ (2.41)	.000531 (1.23)
$\ln(\text{PCT MALE})$	-.000120 [*] (-1.64)	.000056 (.14)
$\ln(\text{PCT ELEM})$	-.012619 (-.80)	-.007712 (-.04)
$\ln(\text{SIZE})$	-.006254 ^{**} (-2.39)	-.015057 (-.88)
$\ln(\text{SES})$	.515578 ^{**} (6.43)	.905411 ^{**} (2.22)
$\ln(\text{SES SD})$	.003860 (.21)	.055689 (.80)
$\ln(\text{PCT WHITE})$	.084018 ^{**} (4.49)	.078000 (1.48)
Phi ratio signif. level	[<.0005]	[.751]

Coefficients represent elasticities; their t-values are in parentheses. + and ++ indicate significance at the .1 and .05 levels for a one-tailed test. * and ** indicate significance at the .1 and .05 levels for a two-tailed test. N = 519.

TABLE A2.--Production Function Estimate: $\ln(\text{DESIRE TO DO WELL})$ as the Dependent Variable. The Effects of Using 2SLS Instruments for all but Background Factors (2).

$\ln(\text{CONSTANT})$	5.502363	1.298243
$\ln(\text{COGNITIVE SCORE})$	.261823 [†] (1.33)	.361532 (.96)
$\ln(\text{SELF PERCEPTION})$	.235023 (.81)	.915264 (1.44)
$\ln(\text{LIKING SCHOOL})$	-.812096 ^{††} (-2.22)	.011850 (.02)
$\ln(\text{TEACH/PUP})$	-.003151 (-.15)	.155950 [†] (1.38)
$\ln(\text{NONTEACH/PUP})$	-.000026 (-1.10)	.000284 (.95)
$\ln(\text{AV EXPER})$	-.007943 (-.64)	-.048360 (-1.15)
$\ln(\text{PCT MASTERS})$	-.000068 ^{**} (-2.37)	-.000299 (-1.43)
$\ln(\text{PCT MALE})$	-.000068 (-.79)	-.000007 (-.03)
$\ln(\text{PCT ELEM})$	.009317 (.51)	-.024914 (-.25)
$\ln(\text{SIZE})$	.005503 [*] (1.89)	.010928 ^{**} (1.98)
$\ln(\text{SES})$	-.027519 (-.19)	-.412091 (-1.30)
$\ln(\text{SES SD})$	-.007239 (-.35)	-.030510 (-.78)
$\ln(\text{PCT WHITE})$	-.071094 ^{**} (-3.58)	-.032899 (-.85)
Phi ratio signif. level	[.136]	[.840]

Coefficients represent elasticities; their t-values are in parentheses. † and †† indicate significance at the .1 and .05 levels for a one-tailed test. * and ** indicate significance at the .1 and .05 levels for a two-tailed test. N = 519.

TABLE A3.--Production Function Estimate: $\ln(\text{SELF PERCEPTION})$ as the Dependent Variable. The Effects of Using 2SLS Instruments for all but Background Factors (2).

$\ln(\text{CONSTANT})$	1.539194	-.034543
$\ln(\text{COGNITIVE SCORE})$	-.126684 (-.86)	-.349214 (-1.04)
$\ln(\text{DESIRE TO DO WELL})$	.193912 (1.02)	.778337 (1.41)
$\ln(\text{LIKING SCHOOL})$	.269032 (.90)	-.021004 (-.03)
$\ln(\text{TEACH/PUP})$	.005014 (.34)	-.130754 (-1.04)
$\ln(\text{NONTEACH/PUP})$	-.000005 (-.29)	-.000304 (-1.37)
$\ln(\text{AV EXPER})$	.007597 (.86)	.039686 (.87)
$\ln(\text{PCT MASTERS})$	.000036 ⁺ (1.54)	.000297 ⁺⁺ (1.93)
$\ln(\text{PCT MALE})$	-.000076 (-1.26)	.000049 (.22)
$\ln(\text{PCT ELEM})$	-.020029 (-1.62)	.009413 (.10)
$\ln(\text{SIZE})$	.001284 (.55)	-.007670 (-.85)
$\ln(\text{SES})$	.271847** (3.28)	.432438** (2.26)
$\ln(\text{SES SD})$	.019134 (1.32)	.034770 (1.18)
$\ln(\text{PCT WHITE})$	.004070 (.21)	.024606 (.59)
Phi ratio signif. level	[.008]	[.850]

Coefficients represent elasticities; their t-values are in parentheses. + and ++ indicate significance at the .1 and .05 levels for a one-tailed test. * and ** indicate significance at the .1 and .05 levels for a two-tailed test. N = 519.

TABLE A4.--Production Function Estimate: $\ln(\text{LIKING SCHOOL})$ as the Dependent Variable. The Effects of Using 2SLS Instruments for all but Background Factors (2).

$\ln(\text{CONSTANT})$	4.467704	3.075830
$\ln(\text{COGNITIVE SCORE})$	.097393 (.57)	.048106 (.12)
$\ln(\text{DESIRE TO DO WELL})$	-.326819 ⁺⁺ (-1.69)	.024592 (.03)
$\ln(\text{SELF PERCEPTION})$	.131223 (.54)	-.051256 (-.06)
$\ln(\text{TEACH/PUP})$	.000479 (.03)	-.094116 (-.69)
$\ln(\text{NONTEACH/PUP})$	-.000029 (-1.63)	-.000196 (-.68)
$\ln(\text{AV EXPER})$	.005812 (.57)	.027071 (.59)
$\ln(\text{PCT MASTERS})$	-.000025 (-.94)	.000005 (.02)
$\ln(\text{PCT MALE})$	-.000052 (-.74)	-.000122 (-.77)
$\ln(\text{PCT ELEM})$	-.008808 (-.59)	.027881 (.39)
$\ln(\text{SIZE})$	.001160 (.43)	-.001777 (-.19)
$\ln(\text{SES})$	.008842 (.07)	.109625 (.28)
$\ln(\text{SES SD})$	-.011139 (-.65)	.003247 (.09)
$\ln(\text{PCT WHITE})$	-.038211 ^{**} (-2.05)	-.030455 (-.90)
Phi ratio signif. level	[.550]	[.330]

Coefficients represent elasticities; their t-values are in parentheses. + and ++ indicate significance at the .1 and .05 levels for a one-tailed test. * and ** indicate significance at the .1 and .05 levels for a two-tailed test. N = 519.

TABLE A5.--Production Function Estimates: $\ln(\text{COGNITIVE SCORE})$ as the Dependent Variable. The Effects of Dropping PCT ELEM (1), PCT MALE (3) or Both (4).

$\ln(\text{CONSTANT})$	-1.009539	-.687628	-.856242	-1.148070
$\ln(\text{DESIRE...})$	.433601 ⁺⁺ (1.93)	.440270 ⁺⁺ (1.97)	.443086 ⁺⁺ (1.84)	.424355 ⁺⁺ (1.75)
$\ln(\text{SLF PERCEP})$	-.219311 (-.86)	-.258190 (-1.01)	-.473945 ⁺ (-1.54)	-.423924 ⁺⁺ (-1.72)
$\ln(\text{LIKING SCHOOL})$	.452444 (1.24)	.406949 (1.11)	.625058 (1.61)	.666198* (1.72)
$\ln(\text{TEACH/PUP})$	.026727 ⁺ (1.51)	.025472 ⁺ (1.44)	.030484 ⁺ (1.54)	.031247 ⁺ (1.58)
$\ln(\text{NONTTEACH/PUP})$	-.000023 (-1.11)	-.000025 (-1.18)	-.000027 (-1.15)	-.000025 (-1.08)
$\ln(\text{AV EXPER})$	.041235 ⁺⁺ (5.23)	.041854 ⁺⁺ (5.35)	.040999 ⁺⁺ (4.70)	.040241 ⁺⁺ (4.59)
$\ln(\text{PCT MASTERS})$	.000065 ⁺⁺ (2.36)	.000066 ⁺⁺ (2.41)	.000073 ⁺⁺ (2.41)	.000071 ⁺⁺ (2.34)
$\ln(\text{PCT MALE})$	-.000111 (-1.54)	-.000120* (-1.64)		
$\ln(\text{PCT ELEM})$		-.012619 (-.80)	-.011368 (-.65)	
$\ln(\text{SIZE})$	-.006499** (-2.49)	-.006254** (-2.39)	-.005500* (-1.86)	-.005685* (-1.93)
$\ln(\text{SES})$	.508170** (6.27)	.515578** (6.43)	.551813** (6.11)	.543252** (6.00)
$\ln(\text{SES SD})$	.003841 (.21)	.003860 (.21)	.007321 (.35)	.007255 (.35)
$\ln(\text{PCT WHITE})$	.085304* (4.56)	.084018** (4.49)	.085010** (4.25)	.085890** (4.31)
Phi ratio signif. level	[<.0005]	[<.0005]	[.017]	[.014]

Coefficients represent elasticities; their t-values are in parentheses. + and ++ indicate significance at the .1 and .05 levels for a one-tailed test. * and ** indicate significance at the .1 and .05 levels for a two-tailed test. N = 519. 2SLS instruments were used for all outputs.

TABLE A6.--Production Function Estimates: $\ln(\text{DESIRE TO DO WELL})$ as the Dependent Variable. The Effects of Dropping PCT ELEM (1), PCT MALE (3) or Both (4).

$\ln(\text{CONSTANT})$	5.535282	5.502363	4.973030	5.086030
$\ln(\text{COG SCORE})$	.252132 ⁺ (1.29)	.261823 ⁺ (1.33)	.326857 ⁺ (1.56)	.307613 ⁺ (1.48)
$\ln(\text{SLF PERCEP})$	.234902 (.82)	.235023 (.81)	.315309 (.98)	.296011 (.95)
$\ln(\text{LIKING SCHOOL})$	-.805389 ⁺⁺ (-2.21)	-.812096 ⁺⁺ (-2.22)	-.763578 ⁺⁺ (-2.09)	-.753900 ⁺⁺ (-2.05)
$\ln(\text{TEACH/PUP})$	-.004172 (-.20)	-.003151 (-.15)	-.003360 (-.16)	-.004218 (-.20)
$\ln(\text{NONTEACH/PUP})$	-.000026 (-1.11)	-.000026 (-1.10)	-.000023 (-.98)	-.000024 (-1.04)
$\ln(\text{AV EXPER})$	-.007740 (-.64)	-.007943 (-.64)	-.011370 (-.91)	-.010698 (-.87)
$\ln(\text{PCT MASTERS})$	-.000068 ^{**} (-2.37)	-.000068 ^{**} (-2.37)	-.000071 ^{**} (-2.42)	-.000070 ^{**} (-2.40)
$\ln(\text{PCT MALE})$	-.000072 (-.86)	-.000068 (-.79)		
$\ln(\text{PCT ELEM})$		.009317 (.51)	.012999 (.74)	
$\ln(\text{SIZE})$	.005640 ^{**} (1.96)	.005503 [*] (1.89)	.005637 [*] (1.95)	.005849 ^{**} (2.06)
$\ln(\text{SES})$	-.025715 (-.18)	-.027519 (-.19)	-.085733 (-.56)	-.075756 (-.51)
$\ln(\text{SES SD})$	-.007318 (-.35)	-.007239 (-.35)	-.008943 (-.43)	-.008894 (-.43)
$\ln(\text{PCT WHITE})$	-.070316 ^{**} (-3.52)	-.071094 ^{**} (-3.58)	-.072635 ^{**} (-3.56)	-.071517 ^{**} (-3.50)
Phi ratio signif. level	[.134]	[.136]	[.109]	[.099]

Coefficients represent elasticities; their t-values are in parentheses. ⁺ and ⁺⁺ indicate significance at the .1 and .05 levels for a one-tailed test. ^{*} and ^{**} indicate significance at the .1 and .05 levels for a two-tailed test. N = 519. 2SLS instruments were used for all outputs.

TABLE A7.--Production Function Estimates: $\ln(\text{SELF PERCEPTION})$ as the Dependent Variable. The Effects of Dropping PCT ELEM (1), PCT MALE (3) or Both (4).

$\ln(\text{CONSTANT})$	1.331223	1.539194	1.164630	1.008625
$\ln(\text{COG SCORE})$	-.107694 (-.73)	-.126684 (-.86)	-.222226 ⁺ (-1.35)	-.203257 (-1.23)
$\ln(\text{DESIRE...})$	.198372 (1.04)	.193912 (1.02)	.200416 (1.02)	.195789 (.99)
$\ln(\text{LIKING SCHOOL})$	.287464 (.96)	.269032 (.90)	.405032 ⁺ (1.33)	.421103 ⁺ (1.37)
$\ln(\text{TEACH/PUP})$	.007094 (.47)	.005014 (.34)	.010486 (.65)	.011876 (.74)
$\ln(\text{NONTEACH/PUP})$	-.000004 (-.23)	-.000005 (-.29)	-.000009 (-.47)	-.000008 (-.40)
$\ln(\text{AV EXPER})$	.006851 (.78)	.007597 (.86)	.010670 (1.12)	.009801 (1.04)
$\ln(\text{PCT MASTERS})$	.000035 ⁺ (1.50)	.000036 ⁺ (1.54)	.000042 ⁺⁺ (1.67)	.000040 ⁺ (1.62)
$\ln(\text{PCT MALE})$	-.000066 (-1.10)	-.000076 (-1.26)		
$\ln(\text{PCT ELEM})$		-.020029 (-1.62)	-.017166 (-1.31)	
$\ln(\text{SIZE})$	.000990 (.42)	.001284 (.55)	.000893 (.36)	.000701 (.28)
$\ln(\text{SES})$	.266614 ^{**} (3.21)	.271847 ^{**} (3.28)	.311559 ^{**} (3.50)	.307011 ^{**} (3.43)
$\ln(\text{SES SD})$	.019626 (1.35)	.019134 (1.32)	.018542 (1.20)	.019191 (1.24)
$\ln(\text{PCT WHITE})$	.003375 (.17)	.004070 (.21)	.013121 (.62)	.012000 (.56)
Phi ratio signif. level	[.008]	[.008]	[.079]	[.065]

Coefficients represent elasticities; their t-values are in parentheses. + and ++ indicate significance at the .1 and .05 levels for a one-tailed test. * and ** indicate significance at the .1 and .05 levels for a two-tailed test. N = 519. 2SLS instruments were used for all outputs.

TABLE A8.--Production Function Estimates: $\ln(\text{LIKING SCHOOL})$ as the Dependent Variable. The Effects of Dropping PCT ELEM (1), PCT MALE (3) or Both (4).

$\ln(\text{CONSTANT})$	4.392552	4.467704	3.878371	3.824267
$\ln(\text{COG SCORE})$	.106856 (.63)	.097393 (.57)	.183852 (1.02)	.189351 (1.07)
$\ln(\text{DESIRE...})$	-.327118 ⁺⁺ (-1.68)	-.326819 ⁺⁺ (-1.69)	-.304460 ⁺ (-1.55)	-.295599 ⁺ (-1.50)
$\ln(\text{SLF PERCEP})$	.138258 (.57)	.131223 (.54)	.254079 (.96)	.249630 (.96)
$\ln(\text{TEACH/PUP})$	.001365 (.08)	.000479 (.03)	-.001216 (-.07)	-.000694 (-.04)
$\ln(\text{NONTEACH/PUP})$	-.000028 (-.162)	-.000029 (-1.63)	-.000025 (-1.32)	-.000025 (-1.31)
$\ln(\text{AV EXPER})$	.005492 (.54)	.005812 (.57)	.001847 (.17)	.001742 (.16)
$\ln(\text{PCT MASTERS})$	-.000026 (-.97)	-.000025 (-.94)	-.000029 (-1.06)	-.000029 (-1.07)
$\ln(\text{PCT MALE})$	-.000048 (-.68)	-.000052 (-.74)		
$\ln(\text{PCT ELEM})$		-.008808 (-.59)	-.005668 (-.37)	
$\ln(\text{SIZE})$	.001024 (.38)	.001160 (.43)	.001120 (.41)	.000997 (.37)
$\ln(\text{SES})$	.004925 (.04)	.008842 (.07)	-.070607 (-.55)	-.071542 (-.56)
$\ln(\text{SES SD})$	-.011119 (-.65)	-.011139 (-.65)	-.013694 (-.80)	-.013500 (-.79)
$\ln(\text{PCT WHITE})$	-.038725 ^{**} (-2.09)	-.038211 ^{**} (-2.05)	-.040405 ^{**} (-2.13)	-.040479 ^{**} (-2.16)
Phi ratio signif. level	[.547]	[.550]	[.541]	[.549]

Coefficients represent elasticities; their t-values are in parentheses. + and ++ indicate significance at the .1 and .05 levels for a one-tailed test. * and ** indicate significance at the .1 and .05 levels for a two-tailed test. N = 519. 2SLS instruments were used for all outputs.

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TABLE A9.--Cost Function Estimates Using Interaction Terms: ln(INSTR) as the Dependent Variable.

	Without	With	Interactions		
ln(CONSTANT)	-29.205934	-5.281399	290.826172	-22.950851	-42.430686
ln(COG SCORE)	2.696233++ (2.34)	2.508117++ (1.69)	66.656114 (.94)	5.200401 (.28)	-4.039674 (-.19)
ln(DESIRE...)	7.002061++ (4.32)	6.323038++ (1.76)	-80.289880 (-.91)	29.615217 (1.07)	35.300905 (1.05)
ln(SLF PERCEP)	3.012350+ (1.43)	1.505651 (.36)	85.497423 (.91)	-24.504595 (.92)	-4.436208 (-.20)
ln(LIKING SCH)	-1.867227 (-.66)	-4.656557 (-.98)	-81.869972 (-1.20)	.439431 (.03)	-15.948030 (-.45)
		SIZE/1000	SES	SES SD	PCT WHITE
ln(COG SCORE)		-.000108 (-.27)	-1.260007 (-.91)	-.367532 (-.17)	.061677 (.29)
ln(DESIRE...)		-.001560 (-1.28)	1.735511 (.95)	-2.525234 (-.85)	-.295879 (-.87)
ln(SLF PERCEP)		.001168 (.72)	-1.655915 (-.88)	3.187246 (1.05)	.065381 (.28)
ln(LIKING SCH)		.000509 (.53)	1.607417 (1.16)	-.144699 (-.08)	.160065 (.45)
ln(SIZE)	.030707 (1.53)	-.028681 (-.26)	.046041 (1.25)	.045786 (1.58)	-.000109 (-.00)
ln(SES)	-2.092896** (-2.55)	-2.854474** (-2.09)	-83.537343 (-1.16)	-2.289856 (-1.45)	-.722098 (-.67)
ln(SES SD)	-.031251 (-.22)	-.346388 (-1.05)	.039326 (.11)	-5.096482 (-.58)	.008402 (.04)
ln(PCT WHITE)	-.062005 (-.36)	-.407084 (-.91)	-.929659 (-1.16)	.131801 (.30)	2.366357 (.74)
ln(SAL)	.146263 (.95)	.344991+ (1.51)	.176241 (.60)	.116214 (.49)	.155982 (.98)
Phi ratio signif. level	[.442]	[.519]	[.930]	[.958]	[.514]

The t-values are in parentheses.

† and †† indicate significance at the .1 and .05 levels for a one-tailed test.

* and ** indicate significance at the .1 and .05 levels for a two-tailed test.

N = 519. 2SLS instruments were used for all outputs and interactions.

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